

# The Mining Journal

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## Metals into Outer Space

ONE effect of the rivalry between the United States and the Soviet Union in rocket construction and space exploration has been a notable acceleration in the tempo of metallurgical development. In fact, the U.S. rocketry and space programme has probably given an even greater impetus to metallurgical progress than the technological revolution of the war and post-war years.

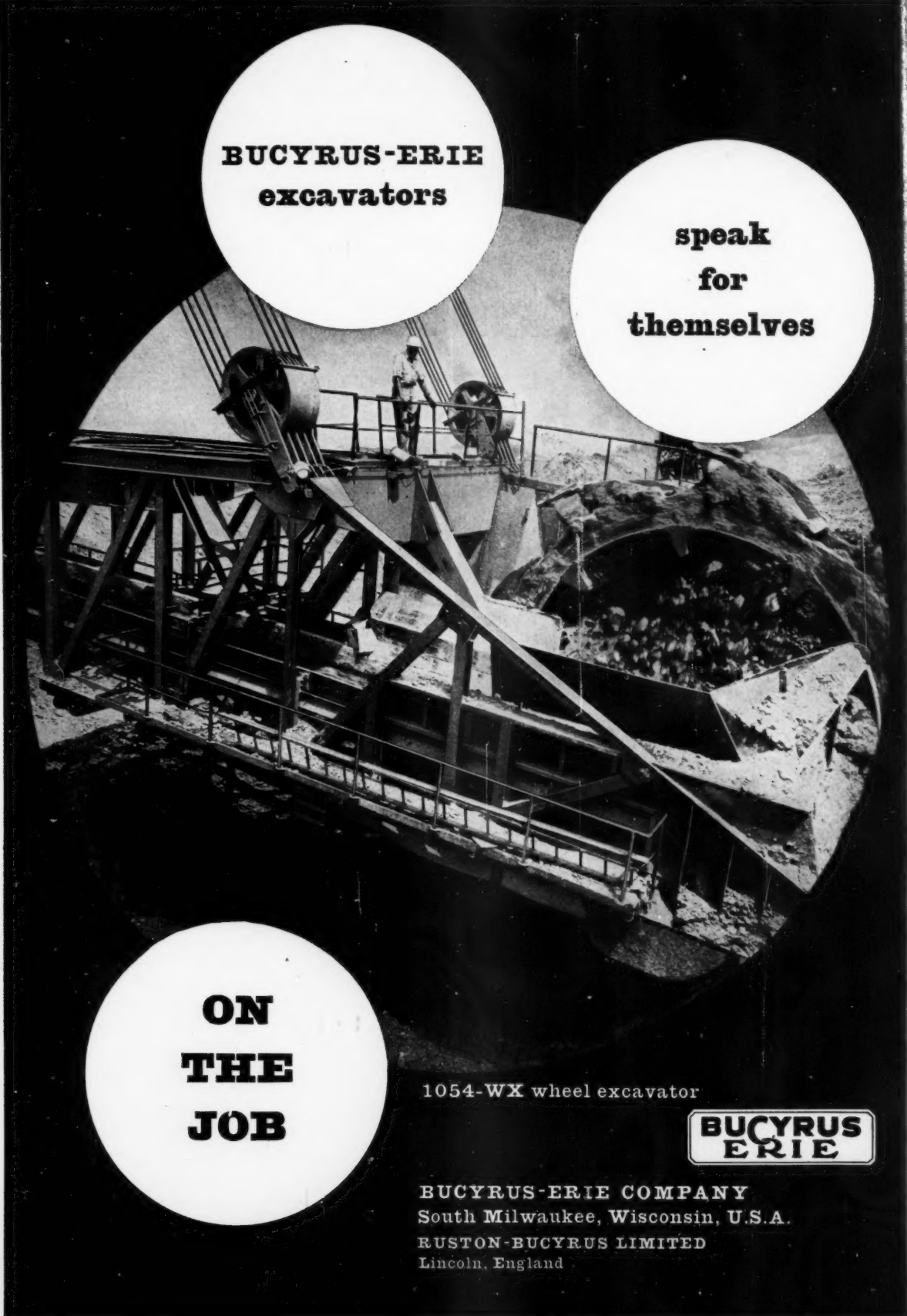
The firing of a second stage Minuteman interballistic continental missile last month involved what is believed to be the largest rocket chamber to be fabricated of titanium and successfully hydrotested. Examination after the firing indicated that the chamber was in excellent condition and capable of being replaced.

Titanium was chosen for this application because it reduces the weight of the chamber by approximately one-third as compared with conventional construction. This, however, is only one of what might be termed, broadly speaking, the two prime considerations in developing materials for use in rockets and sputniks, the other being resistance to heat and to changes of temperature. The ideal metal for space travel, it has been stated, would be as heat-resistant as rhenium, as light as titanium, and as easy to work as steel. Unfortunately the perfect material has yet to be discovered.

It is believed that in the United States alone some 30,000 scientists are working on problems associated in one way or another with high temperature performance. Much of this effort is concentrated on the search for new materials or combinations of materials capable of standing up to very high temperatures and still giving satisfactory performance at ordinary temperatures. Though the so-called "exotic" metals figure prominently in this programme, present indications suggest that some of the more familiar refractory metals, such as tungsten and molybdenum, will also be of major importance in space exploration as will nickel and aluminium, and doubtless many other well-known engineering materials.

At the present time solid fuels are favoured for rocket propulsion because they are simple, cheap and reliable. Currently the principal ingredient for solid rocket fuels is a mixture of granular aluminium and beryllium. It has been predicted that U.S. rocket flights will consume 17,500 s. tons of fine aluminium powder by 1965. Beryllium is claimed to have a higher heat of combustion per unit weight fuel available for propulsion than any other element except hydrogen. Since fumes from beryllium are toxic, however, and could be hazardous near the surface of the earth, this element is unlikely to be used in rocket fuel in the first stage launcher. Beryllium's closest competitors in the field of rocket fuels are boron and lithium, while magnesium is another metal which could be involved.

Caesium, too, may play a leading role in the development of solid fuel rockets. *American Metal Market* quotes Dow Chemical as predicting that a caesium ionic engine could propel an outer space vehicle more than a hundred times further than the same quantity of any other now known liquid or solid fuel. It has been predicted



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that as much as one million pounds of caesium could be required annually for ionic propulsion of orbital and inter-planetary space vehicles.

Additional thrust is obtainable from solid propellants by raising engine temperatures. Rocket flame temperatures have now reached about 6,000-6,300 deg. F. It is expected that by 1970 they will have reached 7,000 deg. F. and by 1975 perhaps 8,300 deg. F. In order to take maximum advantage of the available energy in the fuel, the combustion gases are passed through a nozzle to accelerate them to supersonic speeds. The most critical area, from the standpoint of materials, is the throat, where the maximum temperature and also the maximum abrasion are encountered. A logical contender for this position is tungsten, which has the highest melting point (6,170 deg. F.) of any metal. Weight reduction, however, is also a major problem in nozzle design. Molybdenum, which has a higher strength-weight ratio than tungsten at lower temperatures, can accordingly be used with advantage in nozzle areas not directly exposed to very high flame temperatures. Other potential materials for rocket nozzles include graphite, zirconium and columbium carbides. Another possible answer to this particular problem might be to circulate a liquid metal such as copper or lithium round the throat as a coolant.

Then there are the problems associated with heat of friction to be solved. If a man is to be brought back alive from the moon, means will have to be found of protecting him from the extreme heat—more than 4,000 deg. F.—to which the outer shell of the spacecraft will be subjected. Research workers have stated that the heat problem of recovering men from far out in space is fifty to a hundred times greater than that in recovering America's two pioneer space travellers from their sub-orbital flights. According to *The Wall Street Journal*, there are about twenty metals or combinations of metals with other materials which can withstand heats of more than 3,000 deg. F., but most of these have been discarded as unsuitable. In the case of rhenium, for example, four years' supply at current output rates would be needed to get enough for one space craft.

Increasing attention is being paid to tantalum, tungsten, columbium and molybdenum, but these metals—apart from being difficult to shape—have a strong affinity for the oxygen in the air, resulting in the formation of oxide coatings which weaken them. Despite their disadvantages, these are currently regarded in the United States as the four most promising metals for space work, and more than \$20,000,000 will be spent in research on them during the current year.

Among the most interesting alloys under development is tungsten—25 rhenium, which melts at approximately 5,800 deg. F. and can be used at temperatures almost as high as tungsten itself will withstand, but which—unlike tungsten—does not become brittle upon recrystallization. Rhenium-tungsten alloys are suitable for use in thermocouples for measuring the extremely high temperatures involved in space exploration. A newly developed high-strength columbium-base alloy containing tungsten and zirconium is reported to be finding uses in aircraft and missile applications. Also of great promise are a new series of nickel base alloys which have been under development for the past three years at the Lewis Research Centre of the National Aeronautics and Space Administration.

Among many other interesting developments may be mentioned General Electric's process for producing aluminium oxide or sapphire "whiskers", which used as reinforcing fibres greatly enhance the ability of ordinary metals to withstand high temperatures. The same technique can be applied to other metals such as iron and nickel. Attention is also being given to the development of varnish-like coatings which, when applied to certain metals, increase heat resistance. It has been found, for example, that a coating of molybdenum disilicide enables molybdenum metal to withstand heats of more than 3,000 deg. F.

This stupendous metallurgical effort, which, of course, is by no means confined to America and Russia, may seem remote from the requirements of contemporary civilian life. Experience in the aircraft and motor car industries has already shown, however, that it is only a matter of time before materials and techniques developed for highly specialized purposes find their way into commerce and industry, leading to the introduction of safer and better equipment, more efficient manufacturing techniques. In Britain and the Continent, as well as in the United States, there is already a growing demand from chemical and processing industries for such relative newcomers as titanium, columbium, tantalum, beryllium and others, which, because of their unique combinations of desirable properties, are proving to be the most effective and economical construction materials in a variety of situations where high temperatures or highly corrosive conditions are encountered.

### COST OF A STRIKE

Chile's major copper mines are again in operation, after a stoppage which between August 11 and September 8 caused production losses estimated at almost 45,000 tonnes, or nearly 10 per cent of the annual production of Anaconda's and Kennecott's Chilean mines. The Chilean State is reported to have lost \$6,100,000 in taxes and \$7,000,000 in foreign exchange revenues, while workers' salary losses totalled some 4,550,000 escudos.

Meanwhile, despite the return to work, the dispute remains unresolved. Direct talks between El Salvador union representatives and the Andes Co. were resumed on September 13, but it has not yet been stated when talks with Potrerillos representatives will begin. Moreover, the industry is facing the possibility of new labour conflicts in the immediate future. The Chuquicamata workers' contract expires on December 31 this year; the law requires that demands for the new contract should be submitted by October 1. The El Teniente collective contract expires on March 31, 1962, and their demands must be submitted by January 1.

With the horizon further clouded by new legislative proposals involving further taxes, the short-term outlook for Chile's copper mining industry can only be described as unsettled and changeable.

### A NEW LOOK AT ANGLESEY'S COPPER

In view of the remarkable developments which flowed from the application of modern prospecting techniques to abandoned mines in Eire, in accordance with the programme initiated by the Eire Government and followed up by Canadian capital, considerable interest attaches to the announcement that Northgate Exploration Ltd. is to spearhead a new explorational test of former copper producing mines in the district of Anglesey in Wales. Partners in the venture include the Société Générale des Minerais of Brussels, and Northfield Mines Ltd. of New York. Sir Alfred Chester Beatty retains a continuing interest.

Initially, the group will provide \$150,000 which will be devoted to a thorough exploration of the continuity at depth of the orebody at the Parys and Mona mines. This ground, which has been acquired by a Canadian prospector, Mr. Bill Richardson of Toronto, lies on the estate of the Marquess of Anglesey and Sir Arundell Neave. These mines, which were developed by two large open pits and numerous shallow shafts, yielded 3,000 tons of copper metal annually up to 1773. It is estimated that, over a period dating back to the days of the Roman occupation, they produced upwards of 100,000 tons of copper metal.

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In charge of exploration is Dr. Duncan R. Derry, a well-known Canadian geologist and consultant, who will be utilizing two heavy-duty rigs. Efforts will be directed towards exploring a belt of favourable formation, approximately  $\frac{1}{2}$  miles long by  $\frac{1}{2}$ -mile wide, underlying the area of former openpit mining and underground workings. Most recent records covering the historical operation indicated that the grade of ore, after sorting, averaged in the region of 5.5 per cent copper.

Extensive geological investigation of the Anglesey property, in Dr. Derry's opinion, justifies the initial drilling of from 7 to 8 holes varying in depth from 1,000 to 1,500 ft. This work is designed to test the mineralized zones for new ore shoots below the levels of previous work, namely the 500 ft. horizon on east end workings and the 900 ft. horizon at the west end of the mineralized zone.

The discovery of payable ore in commercially significant quantities below these horizons would provide the best kind of support for those who remain convinced that in Britain, as in Eire, an appreciable mineral potential exists at depths which were beyond economical reach of the techniques and equipment employed in former mining operations.

#### POLAND'S PLANS FOR COAL AND STEEL

A communiqué published by the Central Statistical Office on July 24 concerning the implementation of the national economic plan for the first half of the year, announces that Poland's industrial plan has been 102.7 per cent implemented and that total output during that period increased by 11.4 per cent (in comparable prices).

Coal output increased by 1,476,000 tons, mainly due to the continued rise in labour productivity. The steel industry produced 51,100 tons of steel and 50,500 tons of rolled products more than planned.

There was a notable increase in the output of sulphur. Output at the Tarnobrzeg combine is developing well and the plants there are producing more sulphur than originally planned.

The Council of Ministers has issued additional instructions regarding the national economic plan for 1962, some of the figures being revised upward as a result of the over-fulfilment of production and investment plans, changes in the purchasing power of the population, and new export and import requirements. Among the most important changes are that coal output is to reach 109,000,000 tonnes next year and steel production 7,750,000 tonnes. These targets have been increased by 290,000 and 1,300,000 tonnes respectively.

Plans for the development of the Polish steel industry up to 1980 have now been completed. It is estimated that, beginning from 1965, steel output will increase by some 5,000,000 tonnes every five years. In 1970 Poland will produce 15,000,000 tonnes and in 1980 25,000,000 tonnes. In spite of the planned increase in the extraction of iron ores from 600,000 tonnes in 1960 to 2,500,000 tonnes in 1980, it will still be necessary to meet more than 60 per cent of the demand with imports, mainly from the U.S.S.R.

#### MINING IN THE FAR EASTERN COMMUNIST BLOC

Figures now available show that last year Mainland China produced mined lead amounting to an estimated 60,000 tonnes metal content, or about the same level as 1959. Output of smelter lead was some 70,000 tonnes, or about 5,000 tonnes less than the 1959 estimate. The latter production covered domestic demand exactly in both last year and 1959, it is believed. Mined zinc output in Mainland China held to the 1959 figure of about 60,000 tonnes, smelter zinc

production being given as the same amount for both years. Raw zinc consumption is also reckoned to have been in the region of 60,000 tonnes over the past two years. Chinese tin production for 1960 is estimated to have reached 24,000 long tons tin content of ore mined, as compared with only some 18,000 tons in the previous year.

North Korea is stated to have had a mined lead output last year of some 45,000 tonnes metal content, or about the same amount as estimated for 1959. Smelter lead production is also thought to have stayed at the 1959 level of 25,000 tonnes. Mined zinc production is estimated as amounting to 60,000 tonnes, the same as in 1959, while that of smelter zinc also remained stable at an estimated 20,000 tonnes. The country's consumption of refined lead is given for last year as 6,000 tonnes (unchanged).

A report issued on the mineral wealth of the western Chinese province of Sinkiang states that rich coalfields are situated in the northern and southern foothills of the Tien-Shan Mountains, in the Turfan plains and in the Kashgar region, copper and lead in the Kashgar region, sulphur and nitre in the Turfan plains and near Jarkand, iron ore and lead in the Ili region, gold in the Altai Mountains and the richest jade mines in the country in Khotan. Uranium is further stated to be present in considerable quantity. The exploitation of Sinkiang's minerals, which has only been partially begun, is dependent on the building up of transport facilities throughout the land.

#### TIN MINING IN N.S.W.

Aberfoyle Tin N.L., which is working a tin-wolfram mine in Tasmania, has taken options over leases on the Ardlethan tinfield in New South Wales, and plans an intensive diamond drilling campaign to determine if a large, low grade enterprise can be developed, suitable for working by open cut. The field has been worked intermittently by three mines since 1924, operations being interfered with by periodical drought and shortages of water.

The country rock is granite intruded by porphyry dykes carrying cassiterite, associated with minor quantities of galena and pyrite. The ore occurred in shoots, which were erratic in attitude and had vertical persistence of as much as 1,200 ft. Their erratic course made prospecting and development difficult, and the practice was to mine each pipe-like shoot by winzing because of the difficulty of locating by driving succeeding levels. The shoots were of comparatively high grade, and in one mine disseminated cassiterite beyond the bounds of the pipes was present in sufficient grade for openpit working.

The operating mines in the active period were the Carpathia, Wild Cherry, and White Crystal, the deepest being the Carpathia. A second and much less actively worked group of lodes was the Bygoo, which failed to reach the same degree of importance as the group previously mentioned. Ore treatment was easy, milling practice being gravity concentration for recovery of primary concentrate, and subsequent treatment by flotation for removal of pyrite and galena. A rather substantial deep lead, at a maximum depth of 160 ft. headed from the Carpathia-Wild Cherry group, and has been worked fairly consistently. A similar, but deeper lead is thought to head from the Bygoo group. Alluvial mining is in progress, but lode mining was carried out for about 30 years before depth and costs compelled closure.

About 10 years ago, considerable diamond drilling was done by North Broken Hill, and the results of that work may be an influencing factor with the Aberfoyle company. Test work on the ore is being carried out by Australian Mineral Development Laboratories at Adelaide, and it is thought that improved recoveries of cassiterite can be made.

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## U.K. Ironstone Workings and Land Restoration

**G**EOLOGICALLY, iron is fairly widely distributed and falls in three main categories:

1. The unstratified haematite ores in the carboniferous Limestone and Lower Carboniferous systems.
2. The coal measure iron ores in the Upper Carboniferous system.
3. The stratified ironstone of the Jurassic and Cretaceous systems.

The haematite ores are chiefly found on the west coast, and the only active workings are in Glamorgan and the north west corner of Lancashire and Cumberland. The ore is of a high grade, having an iron content in the region of 50 per cent. It is also low in phosphorus and is now mainly reserved for making special types of iron. Production has steadily declined over the past 40 years from an annual figure of 1,600,000 tons to the present output which is a little under 500,000 tons.

The coal measure iron ores, referred to generally as the clay band and blackband ores, occur in beds varying in thickness from 5 to 18 in. Production was fairly extensive in the 19th century but has steadily declined until now only small quantities are produced in the Potteries for special purposes.

The principal stratified ironstone series are to be found in the Jurassic measures which run in an unbroken line from the River Tees southwards through Yorkshire, Lincolnshire, Nottinghamshire, Leicestershire, Rutland, Northamptonshire, Warwickshire, Oxfordshire, Wiltshire and Gloucestershire to the coast near Weymouth. The main beds are the Frodingham, the Marlstone and the Northampton Sand Ironstone.

The Frodingham ore found in North Lincolnshire is the earliest of the Jurassic beds and has its horizon in the Lower Lias clays. The bed has a normal thickness of 32 ft., with a low iron content of between 18-25 per cent. It is limey in character, varying between 14-21 per cent and is thus suitable for use in the furnaces in conjunction with the siliceous Northampton Sand Ironstone and foreign ore of high iron content. Owing to the sudden rise in the escarpment, the future winning of this ore is almost certain to be underground but despite this fact production has been more than doubled over the past 10 years to nearly 5,500,000 tons.

The Marlstones are located at the top of the Middle Lias series and are found in the Cleveland district and in two main areas in the Midlands.

The Cleveland district was the first major producing area in this country, production starting about 1836 in the Esk Valley. Production has steadily decreased since the turn of the century and is now less than 500,000 tons a year which is obtained entirely by underground mining.

The South Lincolnshire and Leicestershire Marlstone has a low iron content of 20-28 per cent but this is compensated by an increase in the lime content which makes this a self-fluxing ore. Over the past 15 years production has steadily decreased as the bed becomes largely exhausted.

The Oxfordshire and South-West Northamptonshire Marlstone is similar in character and is mostly found under

This survey of iron ore mining in Britain by R. J. Cowan was given at the Chartered Surveyors' Annual Conference at the University of Leicester on July 6, 1961. The paper has been abridged

extremely shallow cover. During the period 1946-57 production was trebled and now stands at about 1,500,000 tons a year.

The Cretaceous ores are geologically extensive but at the present time are relatively unimportant economically.

During the period of deposition of the Upper Lias Clays conditions were not conducive to the precipitation of iron minerals but at the base of the Lower Oolites the Northampton Sand Ironstone was deposited. This bed is one of the most important in Britain and is worked from Lincolnshire across Leicestershire, Rutland and Northamptonshire. The overlying strata consists mainly of Estuarine clays and Lincolnshire limestone which is hard and massive in character and in some places reaches a thickness of 130 ft. The ore bed itself varies in thickness between 12 and 25 ft., of which only 6 to 14 ft. are worked. The iron content of the workable bed is generally between 28-34 per cent as quarried. There has been an extensive development of this field and production has steadily increased to well over 8,000,000 tons, which is about half the total production of iron ore in Britain.

### Exploitation of Northampton Sand Ironstone

There is abundant evidence that the Northampton sand ironstone was worked in Roman times. At the time of the Norman conquest the Northampton Sand area vied with the Weald of Sussex and Kent as one of the chief iron-producing centres in Great Britain.

It is likely that production continued through Mediaeval times until the 16th century when, owing to the passing of rigorous timber laws which forbade cutting of trees, the charcoal burner was prevented from supplying fuel and for two centuries the iron manufacturer was banished from the district. It was not until the construction of the railways, about the middle of the 19th century, when the ironstone was exposed in many cuttings, that the possible importance of the bed was again realized.

The first blast furnaces were erected on the ore bed in 1857 at Weedon and Wellingborough and by 1913 the annual production had risen to 2,000,000 tons.

In 1896 the first steam-crane navy was introduced for loading ironstone and a year later a similar short jib machine operating in conjunction with a transporter, was used for stripping overburden.

Draglines were introduced in 1916 and in their first important application replaced hand labour in the removal of

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Tonnage pulled per 8-hour shift	1200	600
Trips per shift (men)	—	50
Trips per shift (rock)	175	130
Brake applications per shift	350 appr.	380 appr.

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shallow overburden where the shovel was not suitable. With the ever increasing depth of overburden and the presence of limestone the method of stripping became largely centred on the building of larger shovels. In 1917 a long jib shovel was imported from America and put to work near Corby. By 1924 the Ruston 200 steam shovel with a  $4\frac{1}{2}$  cubic yd. bucket was in use and finally in 1933 came a further advance in overburden stripping when the first of the electrically operated Ransome and Rapier 5360 type shovels was built in this country. This type of machine weighs 500 tons, has a 9 cubic yd. bucket, a dumping height of 68 ft. and a dumping radius of 101 ft. It was designed to strip all types of overburden to a depth of about 60 ft. and many are still in general use.

At about the same time the first walking draglines of the S.W. type with a 135 ft. boom and a  $3\frac{1}{2}$  cubic yd. bucket, were used in the Northamptonshire ironstone workings. They had been introduced into Europe from America in 1930, when they were used for canal work in the Low Countries.

As the necessity for developing still deeper areas arose, very large walking draglines, also developed in America, were introduced into the ore field in 1950. These machines were capable of handling 75 ft. of overburden in one operation. Even this capacity was not sufficient and shortly afterwards a British built machine of a similar type was introduced which could handle up to 100 ft. There are now three of these machines in operation, the latest of which has a boom length of 303 ft., a bucket capacity of 22 cubic yds. and weighs 1,775 tons.

### Exploration and Planning of Quarries

Three types of machine are in general use for exploratory purposes:—

1. The percussive drills which obtain their samples as a slurry.
2. The rotary drills employing compressed air or water flush to remove the cuttings.
3. The diamond core drills producing small cores of about 2 in. diameter.

To explore an area it is divided on a plan by means of a grid system and vertical holes drilled at the intersection of the grid lines. This may be broken down to implement the information, additional holes being frequently required to prove the extent and limit of faults, washouts and unworkable areas.

The position of each borehole is surveyed and levelled and a detailed record kept showing the nature and thickness of the strata and the analysis of the iron ore sample obtained, together with other relevant details such as the levels and quantity of any underground water encountered. Collation and assessment of this information enables the reserves to be calculated and the method of development and type of equipment required, to be determined.

The major factors affecting the planning and layout of an area and the type of mechanisation are its shape and size, the dip of the iron ore bed and the depth and nature of the overburden. The size will be governed by topographical features, such as roads, rivers, railways, streams and villages.

Wherever possible initial excavations commence in the area containing the minimum depth of overburden. It is also advantageous if this coincides with the lowest point of the iron ore bed which enables a drainage system to be installed in the floor of the quarry.

The final choice between a shovel type excavator or a dragline is largely dependent on the overburden and the proximity of suitable adjacent areas. The large walking draglines require a firm foundation from which to operate

and are normally located on the uppermost level of the limestone beds.

Should any part of the area to be worked exceed the maximum working depth of the stripping machine it is possible to overcome the problem by the introduction of auxiliary machinery such as a smaller dragline located on the spoil side which handles any excess or by the removal of excess overburden in advance of the operation by means of scraping machinery.

Due to working at great depths, and the limitation in height at which spoil can be dumped, the question of swell in the overburden has necessitated the development of quarries in the form of an arc, working towards the centre. Calculations are made to decide the degree of curvature required taking into account the total depth of overburden, the thickness of iron ore extracted, the dumping radius of the stripping machine and the percentage swell which is of the order of 20-30 per cent.

The ideal method of opencast working in deep overburden is to open up the pit in a semi-circular fashion having an entry at each extremity. In addition to the maximum dump room that this method gives, it has the additional advantages that the stripping machine has a clear swing at each end of the pit so that the machine loading the iron ore can work clear and the railway can be run out at the far end, thus ensuring a continuous supply of wagons. Unfortunately, it is not often that such ideal conditions can be obtained and it is normally necessary to develop from one point of entry only.

Except in the case of the softer outcrop stone, it is usually necessary to drill and blast the iron ore before loading. Occasionally a maximum lump size may be stipulated by the receiving works because of size restrictions at the plant. After ensuring that the surface of the bed is free from overburden contamination a regular drilling pattern is adopted to give uniform fragmentation and reduce to a minimum the amount of secondary blasting.

The method of transport to be adopted for the iron ore depends on the development of the area in relation to the availability or possibility of linking up with a private or public railway system.

The main alternatives are:

1. The extension of a standard gauge railway into the quarry.
2. Motorised truck haulage, loading into standard gauge rail wagons via a tipping dock.

### Restoration

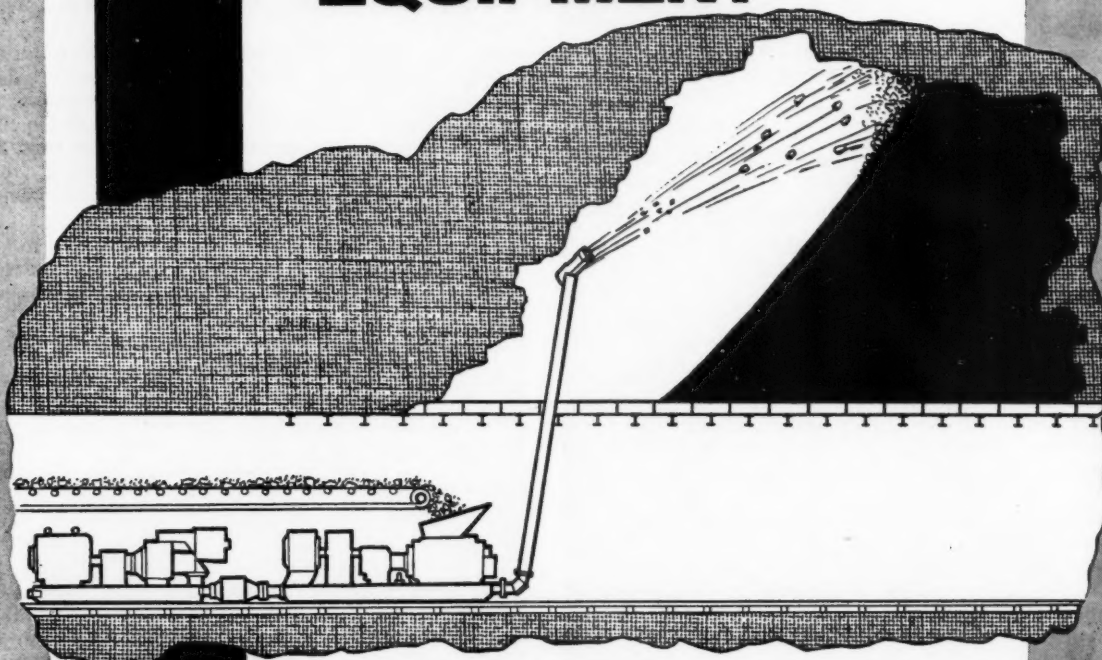
Up to 1933 when manual labour and small draglines were mainly used, restoration presented few problems. With the smaller machines the operator cast the loaded bucket beyond the boomhead and thereby deposited the overburden in a reasonably level state which could be prepared by manual labour to a condition suitable to receive the topsoil.

With the advent of the large stripping machines the problems of rehabilitation increased. The shovels had a rigid arm and the large draglines a direct motor controlled dragrope which caused the spoil to be dumped directly under the boomhead. The result was to leave the overburden in a ridge and hollow formation, generally referred to as "hill and dale."

The overburden in deep quarries also contained a high proportion of limestone, in some places as many as four separate beds with the consequent problems of blasting and handling. Efforts are made to place the bulk of the limestone at the base of the spoil-heap but inevitably some is mixed with the spoil.

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There was no earthmoving equipment capable of levelling such banks and after taking advice the main producers decided on a programme of afforestation in these areas. Meanwhile the shallow areas, representing well over half the land being worked, continued to be restored to full agricultural use including the replacement of topsoil.

When an area became available for afforestation, rides were driven to provide access and fire breaks, and fences erected to keep out rabbits. It was found that planting should take place as soon as possible after working, so enabling the trees to become well established without any competition from undergrowth, thereby reducing weeding to a minimum. The loose spoil and steep slopes of the hill and dale provide excellent drainage.

The type of trees to be planted depended largely on the predominant factors in the overburden such as boulder clay and limestone, but mixtures based on alder, sycamore and larch have proved most successful.

The government took its first step under the Town and Country Planning Act 1947, when in the year 1950 it issued an Ironstone Areas Special Development Order (S.I. 1950, No. 1177) which provided for the levelling of all current workings and for the replacement of topsoil within 400 yards of the swinging end of the quarry or where the overburden was under 35 ft. in depth. There was, however, provision for exemption where the Minister was satisfied that there was an exceptionally high proportion of hard and unfriable limestone in the overburden.

Mining operations now come under the control of the planning authorities and the degree of restoration is laid down as a condition of the permission to win and work the ore. In general it is provided that the overburden shall be levelled to contours which facilitate natural drainage and permit the resumption of normal agricultural operations. Provision is also made for a limited amount of surface soil to be stripped separately and re-spread over an equivalent area of levelled land.

The Mineral Workings Act, 1951, established an Ironstone Restoration Fund under the control of the Minister of Housing and Local Government to provide money for the

restoration of land worked for iron ore by opencast methods. Payment into the Fund is made at the rate of 3d. per ton on ironstone extracted. The producer contributes 2½d. per ton, but can recoup 1½d. per ton in respect of leased minerals by deduction from royalty payments. The extra ½d. per ton is added from the Exchequer. In addition, the producer is required to carry out restoration at his own expense up to a limit of £110 per acre.

Payments out of the Fund can be made as follows:—

1. To iron ore producers, the cost of complying with planning conditions, over and above £110 per acre.
2. To owners, where they incur expense in the replacement of buildings, hedges and field drains and in respect of the management of restored land.
3. To occupiers, where the cost of farming the restored land is higher than comparable operations on unworked land. This applies mainly to the purchase of additional fertilizers required to bring back fertility.
4. To local authorities where they carry out any works for levelling-worked land.

The local authorities have made use of the Fund to restore areas which were left out of agriculture as a result of ironstone workings prior to 1950 and this has resulted in the return to agriculture of some 2,000 acres. Only a very small acreage of such land is left and it will no doubt be dealt with during the next year or two. Since 1950, ironstone operators have restored their current workings progressively to agriculture and approximately another 4,000 acres has been dealt with in this way.

It is estimated that the Fund has paid out a total of £600,000 on levelling, including the spreading of topsoil, and a further £200,000 in grants authorised by the Minister of Agriculture, Fisheries and Food towards bringing the land back to a good state of cultivation and for the afforestation of worked ironstone land. The distribution of this latter sum is of considerable importance, as the long term success of restoration must rest firmly on the shoulders of the landlords and farmers, who should take full advantage of the provisions of the 1951 Act for the purpose of improving the land.

## A NEW LOOK AT UNGAVA BAY

By Claude H. Taylor

**C**HEAP ocean freight rates across the Atlantic and expanding markets for metals in Europe are among the reasons why the multi-million dollar mining corporations are pressing forward with their assessment of the mineral potential of Quebec's northern hinterlands. Their attention is being directed mainly towards Ungava's barren lands, stretching to the Hudson Straits on the north, the Atlantic coastline on the east and down to the fabulous iron ore trough at Schefferville.

The mineral possibilities of Ungava are not especially new to such pioneers as the Cyrus Eaton interests, the Rio Tinto group and to such prospector-engineer veterans as Evan T. Donaldson and Murray Watts of Toronto. These groups and individuals have already received rewards in the form of well-located and important mineral deposits.

Viewed as one of Canada's few remaining virgin areas for exploration, the Ungava area has just recently yielded another new ore possibility. McIntyre Porcupine Mines Ltd., a veteran Ontario gold producer and one of Canada's mining giants, has uncovered an important and exciting copper

discovery. The find has lured some of the nation's top mining corporations into the district.

Considerable credit for attracting the big monied interests to Ungava must be attributed to Donaldson and Watts, the intrepid pair that wooed two publicly-financed speculative companies into utilizing "risk" capital in order to explore the region.

Murray Mining Corporation Ltd. and Raglan Nickel Mines Ltd., indirectly identified with Consolidated Mogul Mines Ltd.—a financing, holding and development medium in Canadian mining—commenced an ore search in Ungava a couple of years ago. The rapid expansion of asbestos reserves by Murray and nickel and copper tonnages by Raglan attracted the big corporations to the region this year.

Murray and Raglan's undertakings are about 10 miles apart, the former's concessions lying perhaps 30 miles south of Deception Bay, a natural harbour on the Hudson Straits. The McIntyre Porcupine discovery, inspiring a major staking rush, is south again and is located about 15 miles north-east of Fort McKenzie and 70 miles south of Fort Chimo.

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McIntyre's copper discovery is within the Labrador trough, the general locale of United States Steel Corporation's Quebec Cartier iron operation from which shipments are now being made to United States furnaces. This district also features the participations of Labrador Mining and Exploration, the Cyrus Eaton undertakings and the Holannah ventures of Hollinger Consolidated Gold Mines Ltd., the latter having originated Iron Ore Co. of Canada's vast projects.

Until quite recently the McIntyre discovery had resulted in approximately 1,500 claims being recorded along the new copper belt. McIntyre staked in the neighbourhood of 400 claims.

A syndicate headed by Dome Mines Ltd.—another veteran Ontario gold producer—has staked a block of 120 claims north and south of McIntyre's holdings. Equal participants in the syndicate are Area Mines, Locana Mineral Holdings and Mirachimi Mines. Certain of these participants shared in the original base metal discovery in the Mattagami district of Quebec which has since turned out to be of major importance. Conwest Exploration and other Toronto-based interests have also staked a sizeable acreage of claims. Several showings have been uncovered on ground staked by the McIntyre interests. So far grab samples have indicated some impressive results. Some silver is associated with the copper.

This season's accelerated ore estimates at the Murray and Raglan operations have created much discussion about the economic possibilities of these ventures. Already Canadian, United States and South African senior mining corporations have examined the results of work performed on these properties. Provision of services and so on would permit cheaper shipment of asbestos, nickel and copper to the European market over similar material moving overseas from the Port of Montreal or other St. Lawrence Seaway points.

Murray Mining Corporation Ltd. holds two concessions in the Ungava region, which have been granted by the government of Quebec province. Diamond drilling and extensive bulk ore tests now indicate an ore deposit approaching \$400,000,000 in value. Drilling is far from finished as the deposit has not been delineated as to length or depth. The latest estimates, submitted by company engineers, credit Murray with 14,500,000 tons of drill indicated ore and 4,000,000 tons of inferred ore. Overall grade of asbestos is between \$18 and \$20 per ton. This season's drilling up to the beginning of August added about 3,000,000 tons to original ore estimates and probing has been continuing.

Raglan Nickel Mines Ltd., situated about 10 miles distant from the asbestos deposit, also holds approximately 1,060,000 shares of the 6,000,000 shares of Murray outstanding.

Raglan's concession is generally known as the Cape Smith—Wakeham Bay area and contains nickel, copper and asbestos. So far, however, asbestos has not attracted much attention.

Diamond drilling on the Cross Lake occurrence of Raglan has indicated a continuous nickel—copper zone for over

1,200 ft. in length and down dip extensions on some ore sections range to over 600 ft. So far work has outlined 3,000,000 tons of ore averaging 1.60 per cent nickel and 0.70 per cent copper.

Exploratory drilling, carried out earlier at a point not too far distant, established another deposit of roughly 500,000 tons of ore grading higher in both nickel and copper. It is assumed drilling between these deposits will add materially to tonnages already recorded. Two rigs will continue exploratory probes until late this year in view of the fact that workers now have adequate quarters for fairly severe weather.

Sufficient ore tonnages have been indicated on the Murray site to justify the establishment of a 3,000 ton per day milling plant. This, together with two town-sites and all ancillary facilities to support the operation, would require an estimated \$40,000,000. Establishment of the Murray as a producing operation, however, would make it a relatively simple and fairly cheap programme to bring the Raglan nickel and copper deposits to productive life.

Since the market for asbestos, nickel and copper would be in Europe, road communication is essential from the mine site to Deception Bay. A road is now being surveyed while a dock site has already been surveyed for ships to transport future asbestos fibres from Deception Bay to Europe.

At the moment there are few undeveloped rich ore plums in Canada and for the record the majority of the major discoveries in Canada in the past have eventually channelled to senior mining corporations. Perhaps then, it is natural, to see representatives of the multi-million dollar mining corporations flying into Ungava to examine structure, drill holes and bulk ore tests from the Murray and Raglan participations. Usually important ore discoveries attract major financing participations. It will indeed be interesting to see who eventually pockets the profits from the concentration of these asbestos, nickel and copper reserves in the future. There is still the possibility that these deposits can eventually be brought to productivity by the publicly financed companies in view of the interest already shown by overseas capital and by the Quebec government.

The entry of McIntyre Porcupine, Dome Mines and Falconbridge Nickel Mines to new participations in Ungava will undoubtedly raise the prestige and the merits of the district, which has long been the home of the Eskimos and more recently the locale of Canada's northerly Dew Line.



Sampling the discovery outcrop of the asbestos project of the Murray Mine Corporation

# The Outlook for Beach Sand Minerals

**T**HE beach mining industry describes the exploitation of the economic concentrations of the heavier minerals rutile, zircon, ilmenite and monazite which occur in sand dunes, generally in the vicinity of beaches or coastal plain areas and deposits located inland from the shore-line.

From a humble beginning in 1934, the industry, activated by the World War and the post-war demands for its products, has grown into an important mining contributor to the prosperity of Australia, its total output of saleable products to December, 1959, being valued at approximately £40,000,000. In the post-war era, Australia has maintained its established position as the world's largest producer of rutile.

The rutile and zircon concentrations extend around the Australian coastline, and the economic deposits occur on the east coast from the Port Kembla district up to Frazer Island, with the richest occurrences from Newcastle to North Stradbroke Island. In Western Australia these are in the Cheyne Bay, Wonnerup and Busselton areas.

The mining and concentrating methods for producing a high grade concentrate from the comparatively low grade orebodies are most commonly by suction dredge and spiral concentrators.

The separation plant or dry mill methods using spiral concentrate feed involve tabling, drying and high tension electrostatic and electromagnetic units. These are adapted in varying flow sheet arrangements according to the mineral composition and to results obtained in the laboratory and/or pilot plants, or from practice and experience gained by established companies.

Flotation is used at Byron Bay to produce high-grade zircon.

Specifications for the quality of the saleable products are high and call for close metallurgical control. Up to 23 different minerals have been recognised in the black sands. In all, four—zircon, monazite, ilmenite and rutile—are saleable.

In the post-war years, up to 1950, rutile was consumed in the manufacture of welding rod coatings, alloys, ceramics and miscellaneous uses. From then on the picture altered slowly until 1952-53, when the pattern change accelerated rapidly. By 1954, the production of titanium, the so-called "wonder" metal of the future, was increasing.

Encouraged by this decision, Australian beach mining interests, with a tremendous upsurge of then justified optimism, and concentrated endeavour in the pegging, acquiring and transactions in leases, together with expansion of wet and dry plants, in a few years reached the startling and impressive output by 1957 of 217,464 tons of the saleable minerals, rutile and zircon.

Spot prices in 1956 reached £150 per ton for small tonnage lots. The average export price the same year from all producers was approximately £65 per ton. However, by late 1957 and early 1958, due in the main to restrictions in the construction of military aircraft and the accumulation of rutile stockpiles in the U.S., the demand substantially lessened and price decreased with detrimental effect to many of the companies in the Australian industry.

The late-comers to the industry, Western Australian companies, became established in 1956 to produce ilmenite, but unfortunately, they too were caught in the maelstrom of market demand and price.

## Zircon

Zircon is used in refractories, foundry facings, porcelain, enamels, pottery and metal alloys, and is also the source of the metal zirconium.

Current trends in the rutile market give added interest to the views of Mr. M. G. Bailey in his address last year to the Southern Queensland Branch, Australasian Institute of Mining and Metallurgy, Brisbane. Mr. Bailey is chairman of Titanium and Zirconium Industries Pty. Ltd., Stradbroke Island, Moreton Bay, Brisbane. This article is abstracted from his address as published in a recent issue of the "Queensland Government Mining Journal"

Its production over the years has more or less followed the production of rutile, with the price range from £10 to £11 per ton. In 1957 in contrast to the depressed rutile market there was a steady demand for zircon tonnages available. At the end of that year the price had risen to £17 per ton with the average yearly price to £13 per ton. In 1958 and 1959 these prices, together with an increased demand, enabled producers to profitably extract zircon from the stockpiled concentrates where these were available. The significant figure of 110,000 tons of zircon was produced in the year 1959.

Australian demand for zircon is limited and estimated at about 2,000 tons annually, and exports have been mainly to the U.S.A. and U.K.

The significant producer of zircon apart from Australia, is the U.S.A. Brazil and South Africa and India are other producers; the latter country's reserves are reported to be in the order of 10,000,000 tons.

## Monazite

Monazite, a thorium rare earth phosphate, has a major application as magnesium thorium alloys in the aircraft and missile industry, also in the manufacture of lighter flints which are essentially cerium and the lighter lanthanons alloyed with iron, whilst the thorium compounds derived from monazite are manufactured into gas mantles. The cerium group of rare oxides are the base for polishing agents whilst the other compounds of monazite have adaptation in the glass, enamel and electronic industries.

The monazite concentrate is recovered as a by-product of zircon and rutile production by a few of the Queensland and New South Wales producers and also from an operator in West Australia. Tonnages of low grade monazite concentrates are stockpiled each year and are a potential reserve for high grade monazite. Production of saleable monazite commenced in 1948 with a total of 167 tons. For 1959 this was 979 tons—the influence of West Australian output being significant in this total.

Monazite was sold in the order of £150 per ton on the open market prior to July 1 1957, when the Commonwealth Government prohibited the export of monazite concentrates to ensure adequate supplies of thorium for the Australian Atomic Energy Commission. With the development of the ilmenite deposits in West Australia, potential monazite production has been substantially increased, and exports to the U.K. and U.S.A. and other countries may now be permitted under certain circumstances. During 1958 the domestic price of monazite was subject to negotiation with the A.A.E.C. Overseas there was a sharp fall in the price of monazite towards the end of 1958, when alluvial monazite was offered at £40 per ton. Australian exports for that year were nil, whilst in 1959 some 300 tons were shipped.

## Ilmenite

Eastern Australian deposits of this iron titanite mineral with approximately one-half the titanium dioxide content of rutile, have unfortunately a high chromium content which precludes its use in the titanium oxide pigment industry, and large tonnages are dumped annually. (This applies to the magnetic product from existing plants.)

Production of ilmenite in West Australia first commenced in 1956. These deposits, fortunately, have a low chrome content, enabling it to be sold for use in the pigment industry. Overseas markets have been very competitive and the full production capacity available in West Australia has yet to be realised.

In 1958 the reported exports of ilmenite were 56,243 tons. Of this, 23,000 tons were shipped to Burnie, Tasmania, for manufacture of titanium pigment for use in paints. Of the remaining tonnages exported, these were to the U.K., Japan, France, the Netherlands, U.S.A. and Belgium. All Australian requirements of ilmenite are satisfied by local production and in 1958 no ilmenite was imported. Its price is a subject of negotiation between buyer and seller, and in 1958 this was £5 to £6 per ton f.o.b. Last year there was a downward adjustment to approximately £4.

## Rutile

This mineral is the richest source of titanium dioxide, the specifications for sale being in the order of 96 per cent  $\text{TiO}_2$ . Because of this high content, titanium metal production companies use rutile extensively. The welding industry consumes rutile in the coating of welding rods to produce a fluid slag and impart arc stability. It is also the raw material for a number of titanium compounds adapted to the ceramic, glass, paint, chemical, electrical and electronic industries.

The Australian production peak in 1957 of 129,000 tons from Queensland and New South Wales was cut approximately 35 per cent in 1958 and 1959, when for both these years production was approximately 83,000 tons annually.

Of the twenty-nine companies operating or about to commence operation on the eastern coastline in 1957, thirteen are now in production. Practically all are well below plant capacity. Small quantities of rutile were produced in West Australia in 1958 and 1959. Australian consumption was about 1,500 tons in 1958.

With regard to the metal titanium so far none has been commercially produced from ilmenite because of its penalty of chemically combined iron and half the titanium oxide content compared with rutile.

## The Future

What is the future of these minerals?

The world's production of monazite continues to exceed demand. The possible use of thorium for atomic energy has been a factor in maintaining the high level prices to 1959. It now appears that thorium is unlikely to be important in the atomic sphere for 10 to 15 years.

The recovery of rare earth salts at Elliott Lake, Canada, came into operation in mid-1959, and this plant which utilises solvent extraction for the recovery of thorium from the waste liquors produced in the uranium milling operations of the Blind River area, produces a substantial proportion of the current world requirements.

Monazite has no foreseeable economic future for the Australian producer, but as its production is small, this situation is relatively insignificant.

The availability of zircon from a world viewpoint is extensive with a growing diversity of supply. Whilst there is no scarcity of the mineral, production in Australia is essentially related to rutile production which latter cannot favourably

be increased in the next few years should present prices be maintained. The record production of 110,000 tons in 1959 is not expected to be maintained despite the fact that zircon-rich stockpiles are not exhausted. There does not appear to be any reason for any substantial increased demand for "run of the mill" zircon, particularly as one of its main uses as foundry sand has other available materials competitively ranged against it. However, we should not lose sight of its developing uses in the refractory and electrical field.

The east coast Australian ilmenite has been, and will continue to be, dumped because of impurities precluding its sale for titanium pigment manufacture, and as such will be a debit to production costs of rutile and zircon. The magnetic product from areas worked to date has a low chrome ilmenite which could be separated at an uneconomic cost. Magnetic fractions from deposits further north are relatively low in chrome, but no deposits have been proved large enough to warrant exploitation at current prices.

West Australian ilmenite of high quality for paint pigments unfortunately came into production at a time when world demand slackened. As intimated earlier the large tonnage available throughout the world at low prices assures a competitive ilmenite market for some time to come.

West Australian producers are very dependent on these world markets and tie in closely with their ability to produce economically at the large available plant capacity.

The possibility of using rutile rather than ilmenite as the raw material for titanium pigment is being investigated and production realised. It costs about £39 per ton to extract titanium dioxide from ilmenite. At £45 per ton, rutile could compete. However, the determining factor is likely to be the anticipated relationship of ilmenite and rutile prices in the long term.

From the tonnages produced and the prices received, rutile's future means the future of the beach mining industry in eastern Australia. This correctly infers that if the market ceased, it is unlikely that zircon, monazite and ilmenite would survive.

Can rutile, with its high content as a supply of raw material for the two main outlets, welding rods and titanium metal manufacture, be superseded by other still cheaper sources of titanium such as Sorel slag, Prevoskite (used by Russia) or ilmenite?

Here we must state that the price of the raw material in relation to the cost of processing becomes significant. A cheaper source may be more costly to process. Indications are the welding rod industry would draw a constant but steadily increasing tonnage of rutile which is high in  $\text{TiO}_2$ .

The outlook for titanium metal is improving gradually, and since the slump in price of rutile and ilmenite, the demand for the metal, following the heavy cut-back in military requirements, is being steadily won for industry and manufacturing purposes by the introduction of new alloys, and this aspect could well open up new horizons.

Whilst consumption of rutile is for the metal titanium and the welding rod manufacture, chlorine processes using rutile as a source of titanium oxide as pigment instead of from ilmenite cannot be overlooked.

Regarding rutile stocks, a survey indicates that world stockpiles exceed present consumption to a degree and extent that some rutile stockholders, buying earlier during the high price contract stage, are cutting their losses by selling at current low prices. This has the effect of keeping the market suppressed, but this situation will eventually be resolved and will take time.

It is suggested that 1961 will be the testing year for the industry. After that, we may look forward to some improvement. Our optimism must of necessity be tempered with realism. For the continuation of the Australian rutile industry, present prices are too low. It is most essential that it be stabilised at a figure reasonable to the buyer and consumer and profitable to the producer.

## Technical Briefs

### Flotation of Extremely Small Particles of Galena and Sphalerite

In a recent report issued by the U.S. Bureau of Mines the result of flotation studies on samples of extremely fine grained lead-zinc ores are summarized. (*Report of Investigations 5765.*)

It is generally thought that recovery falls off when the particle size is diminished below a certain level, and a review of twenty operating mines indicates that the current practical limit in the flotation of lead-zinc ores occurs when about 25 per cent of the particles are less than 20 microns. On the other hand, in certain cases, the optimum particle size range for flotation has been determined as being between 400 and 1,600 mesh. These recent investigations have shown, however, that in some samples liberation did not take place until the ore was ground to 96 per cent-325 mesh or 76 per cent-1,600 mesh.

In another instance primary grinding through 400 mesh followed by regrinding the first lead cleaner concentrate through the 1,600 mesh provided adequate liberation of galena from sphalerite although a few sphalerite particles contained galena inclusions about three microns in size.

Again the examination of another ore revealed that although the galena and sphalerite were essentially liberated in the—100 plus 150 mesh range, much of the sphalerite was locked with carbonaceous material in the micron range and the smallest inclusions were in the order of one micron.

The problem of flotation of extremely small particles therefore exists and the investigations have shown that flotation

can be effectively applied to the selective recovery of exceedingly fine-grained sulphide minerals, separation of galena from sphalerite being obtained on samples ground through 1,600 mesh in which most of the particles were smaller than five microns.

Overall results from tests on six ores indicated recoveries of 72 to 95 per cent of the galena in concentrates assaying 57 to 65 per cent Pb and the production of zinc concentrates varying from 52 to 63 per cent Zn with recoveries of 81 to 93 per cent.

Generally, studies on mill feed samples also indicated that by grinding to approximately twice the fineness of the commercial flotation feeds, lead and zinc recovery could be improved from 5 to 8 per cent in their respective concentrates. In like manner the zinc concentrate grade could also be increased by about 9 per cent with a reduction in lead concentrate of about 7 per cent. It is true that such fine grinding may not prove economic; improved metallurgy may show sufficient advantage in some cases. Normal reagent combinations were found effective in most cases but fine sphalerite tended to float with the galena and some fine galena was lost in the tailing with conventional collectors, and the use of diphenyl thiocarbazon was studied since its reactive nature with lead ions is known and is structurally similar to thiocarbonilid. Using it as a solution in lime water enhances both selectivity and recovery in the very fine size range when it is employed as the galena collector on some ores.

#### FEATURES OF OPERATIONS AT M.T.D. MANGULA

One of the most interesting features of the plant of M.T.D. (Mangula) Ltd., Southern Rhodesia, is the use of autogenous grinding using Aerofall mills to reduce — 8 in. feed to approximately 60 per cent — 200 mesh.

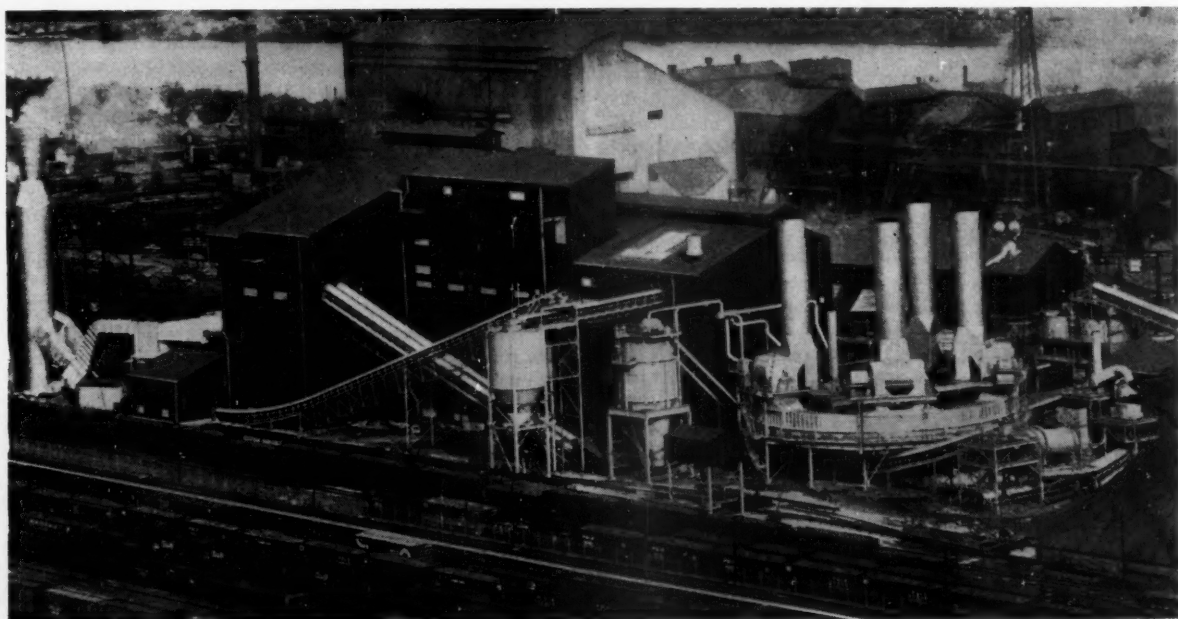
For the correct operation of the Aerofall grinding mills, the ore feed must be segregated. The feed conveyor discharges on to a vibrating grizzly with bars at 3 in. spacing.

Under each ore bin there are pairs of vibrating feeders which are actuated by the master controls to govern the feed rate of each product to each of the two Aerofall mills. Due to mining conditions the size of the mill feed varies from time to time and the products usually contain 50-70 per cent — 8 in. + 3 in. and 50-30 per cent — 3 in.

The grinding circuit consists of two identical sections of 22 ft. dia. by 5 ft. 2 in. Aerofall mills, which can handle a maximum of 3,900 s.tons per 24 hours. Although these are autogenous grinding units, the mills have a charge of 11 to 12 tons of 5½ in. diameter forged steel balls as inertia bodies. These mills are air swept, with the incoming air which is delivered by the main fan being heated by an oil burner unit fitted to the duct ahead of the mill. This heating prevents classification difficulties caused by the moisture added to the ore underground to avoid dust nuisances.

From the mill the air draws the ground mineral up an inclined duct to the

Using iron ore fines from the company's three mining divisions in Michigan, Minnesota and New York, what is claimed to be the world's largest sinter line has recently been placed in operation by Jones and Laughlin Steel Corporation at their Aliquippa, Pa., site. It is capable of producing over 225,000 net tons, or 3,000 railway wagon loads per month, of high quality blast furnace feed. From left to right, the sinter plant's main stack with its dust-collection system, the main sintering buildings and material handling equipment and, at right, the cooler



horizontal classifier. Rock chips fall back down the inclined duct into the mill, while in the classifier other oversize material is removed after having a large percentage of entrained fines winnowed by the air blast from the reflux fan.

The oversize is returned to the mill feed by a horizontal 24 in. by 11 ft. centres conveyor, and an inclined 24 in. by 55 ft. centres conveyor.

From the classifier, the ground product at approximately 60 per cent — 200 mesh is delivered to a battery of six collector cyclones, 8 ft. dia., mounted over a sealed 400 ton (nominal capacity) surge bin.

The air from the cyclone collectors passes through the main fan and in part is returned to the mill. Part of the air is passed through the reflux fan and part of the air is bled off to atmosphere after passing through a wet venturi scrubber, two hydro separators in parallel, and the bleed-off fan. This system enables the circuit to be kept under negative pressure.

Although the major part of the comminution is by means of these mills, a certain amount of oversize material which settles in the conditioner following the agitators used to pulp the dry ground feed, is in fact pumped to a hydrocyclone and the underflow reground along with the rougher concentrate in a conventional ball mill.

The flotation circuit itself is fairly straightforward, the rougher concentrates being classified in a cyclone and the underflow reground so that all cyclone overflow only passes to cleaner cells via a conditioner where a further collector is added. The cleaner tailing returns to the conditioners ahead of the rougher circuit.

Reagents used consist of 1.24 to 1.5 lb. per ton of lime, part being added to the pulpers and part to the regrind mill; 0.16 lb. per ton potassium amyl xanthate of which 0.06 lb. is added ahead of the cleaner cells and T.E.B. frother amounting to 0.04 lb. per ton added ahead of rougher flotation.

The plant handles a maximum of 3,900 tons per day making a 93 per cent recovery from a head value of 1.224 per cent Cu. (of which 0.063 per cent is oxide copper) and yields a concentrate 51.18 per cent copper.

#### COPPER-LEAD-ZINC SEPARATION

The Sindicato Minero Pacococha S.A. mill is a 125 ton per day copper, silver, lead, zinc, selective flotation mill. It is located only three hours by car from Lima, Peru, in the high Peruvian Andes at an altitude of approximately 14,800 ft.

In this plant the separation of copper, lead and zinc follows the conventional pattern involving making a copper-lead bulk concentrate which is retrained depressing the copper minerals and allowing galena flotation. In addition a unit flotation cell is employed in the grinding circuit to recover a high percentage of copper as a concentrate containing little lead.

This is because the copper minerals prove to be much faster floating than the lead mineral and their removal greatly assists the next stages. A concentrating table is provided to reduce the lead content in the unit cell product when the percentage runs too high, and provision is also made for the treatment of the unit cell concentrate in the copper-lead separation circuit.

The bulk copper-lead concentrate is recovered by using Xanthate 350 as collector, sodium cyanide, zinc sulphate



The only means of approach to the Braden copper mine, which is some 8,000 ft. up on the western slopes of the Andes in Chile, is by a narrow gauge railway, 42 miles long. The mining camp is built on the side of a mountain. Recently the mining company renewed the wire rope for their Bi-Cable Ropeway which conveys the concentrates from the concentrator to the smelter. This ropeway is four miles long and has two spans, one of 2,500 ft. and the other of 2,000 ft. The order for the new rope went to British Ropes Ltd. of Doncaster and branches who supplied 3,500 ft. of 1½ in. dia. locked coil tramway track cable; 3,000 ft. of 1½ in. dia. of the same type of cable, and three lengths, each 16,700 ft. of 1 in. dia. 6 by 21 traction cable. The locked coil track cable is the only type of rope manufactured by British Ropes Ltd. containing wedge or trapezoidal inner shaped wires

and sodium bisulphite as zinc depressor and cresylic acid as frother, and is conditioned with further cyanide, raising the pH value to 11.4 with lime. This depresses the copper mineral so that a lead concentrate can be separated. The tailing from the bulk flotation is subsequently conditioned with copper sulphate and the sphalerite floated.

#### COMMERCIAL APPLICATION OF PELLETIZING DISCS

Pelletizing discs can now be used for a variety of materials in addition to preparing iron ore sinter mixes, as the result of four years of development work in the laboratories of the Dravo Corp. in Pittsburgh and reported in *American Metal Market*.

Many kinds of fines and powders which often have been considered waste products can now be converted into pellets large enough for commercial use. Dravo is under special licence from Lurgi Co. of Frankfurt, Germany, to manufacture and market the discs. They are expected to find growing use in ferrous and non-ferrous minerals preparation, and also in the non-metallics fields.

From the results of laboratory tests and field experience, Dravo lists these major advantages of disc pelletizing:

(1) It offers an economical method of reclaiming waste materials. One such is rock wool. Previously trucked away to a waste dump, the fines can now be pelletized and re-introduced to the furnace.

(2) It permits economical upgrading of fines to facilitate better handling and

packaging, thus improving marketability. Many types of powders can easily be produced as pellets.

(3) It offers a way of preparing materials economically for an additional processing step, such as sintering, firing, drying or roasting. Since pelletizing is an intermediate step in the processing, its low cost is an important factor. A typical example of this function is the pelletizing of beryllium ore before it is fed into a muffle furnace to produce beryllium oxide.

This last advantage of pelletizing is believed to be particularly significant. It is pointed out that a disc, as compared with a balling drum, produces a more uniform product, and reduces or eliminates screening and the need for recirculating loads.

Any material which includes 25 per cent or more of 200-mesh particles has a good chance to pelletize. Materials which are water soluble, or have some degree of water solubility, usually pelletize easily and, consequently, the particles need not be as fine. Materials with less than 25 per cent of 200-mesh particles may require special binders. However, Dravo has found that about two-thirds of the materials pelletized without any binder except water.

While particle size and type of binder are the principal factors in determining whether a material will pelletize, various adjustments on the disc allow a degree of variation of pellet size. Pan speed, pan angle, plough arrangement, as well as location of feed and moisture application also are factors influencing the formation and growth of the pellets.

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## MINING MISCELLANY

Figures issued recently in Warsaw for the first half of 1961, give Polish zinc production at some 90,000 tonnes, 4.1 per cent higher than for the comparable period in 1960, when it amounted to 87,000 tonnes. Over the same period, output of furnace aluminium rose by 106.4 per cent, from 11,400 tonnes to 23,500 tonnes; hard coal production rose by 2.9 per cent, from 51,600,000 tonnes to 53,120,000 tonnes, and lignite by 6.7 per cent, from 450,000 tonnes to 490,000 tonnes. Production of coke rose by 5.3 per cent, from 5,800,000 tonnes to 6,200,000 tonnes, and pig-iron by 6.9 per cent, from 2,200,000 tonnes to 2,390,000 tonnes. During the first six months of this year, work started on the building of the Miasteczko Śląskie non-ferrous metals combine for lead, cadmium and other productions. This combine should be in operation by 1964.

Preliminary investigations of magnesite in the Pungar and Lahore valleys of Almora show that approximately 14,500,000 tons of magnesite would be available. The State Government proposes to intensify all mineral investigations in the Uttarakhand Division. Intensive drilling and geological mapping in the Kajrahat Limestone at Kota, Mirzapur, reveal a reserve of 20,000,000 tons of cement quality limestone, while the reserves of the adjacent areas are being worked out. A calcite deposit, about 5,000 tons, occurring at Parosi in Mirzapur, has been found suitable for the chemical industry.

Coal supplied the energy required for 66 per cent of the electricity generators in the U.S. during 1960, according to a report of the National Coal Association, in New York. Gas supplied 26 per cent, and oil 8 per cent. Electric producing plants consumed 176,600,000 tons of coal during 1960 costing an average \$6.26 per ton. This price was 1.7 per cent lower than in 1959.

Pine Point Mines, controlled by the Consolidated Mining and Smelting Co. of Canada, are negotiating with the Canadian Government on the construction of a railway between Grimshaw, Alberta, and the Great Slave Lake, in the North-west Territories. The company have plans for their major lead-zinc property at Pine Point, near Great Slave Lake, to be ready for production when the railway is completed. Open-pit ore reserves are estimated by the company at around 5,000,000 tons, but it is considered that this figure may be conservative.

Production of phosphates from the Jordan Phosphate Mines during 1960 amounted to 391,640 tonnes, of which 368,553 were of 70-72 per cent purity. Output figure for 1959 was 55,000 tonnes. Production of superphosphate has also begun. Export sales of phosphates during 1960 totalled 329,006 tons.

Mexican mineral output fell during the first four months of 1961, compared with the same period of 1960. Production of gold dropped from 108,992 troy oz. to 78,003; silver from 15,960 troy oz. to 14,580; copper from 22,776 tonnes to 18,625, and lead from 74,889 tonnes to 59,395. On the other hand, zinc production rose to 89,280 tonnes, from 87,255 in 1960.



This photograph shows "Terylene" reinforced conveyor belting, made by the Leyland and Birmingham Rubber Co. Ltd., in use at Bickershaw Colliery, Lancashire. The N.C.B. has now placed substantial contracts for this belting. The particular location at Bickershaw Colliery is a gate conveyor in a section of the pit where rock falls and shifting of the conveyor alignment due to old workings are common. Despite this, substantially the same belt has been running for over 12 months

An enquiry into the legal status of the Netherlands state-owned mines is to be undertaken by a high-level Commission, appointed at The Hague. At present the mines are operated as a nationalized industry under the Board responsible to M. de Pous, Minister for Economic Affairs. The Commission is to advise the government on whether the mines should be granted corporate status, and if so, to make recommendations on the form to be taken.

The newly-formed State trading concern, Misr Foreign Trade Co., has taken over the importation into Egypt of metals. This company's address is 7/0, Soliman Pacha Street, Cairo, U.A.R.

The Soviet Union has announced that it is to aid the Kingdom of Cambodia in the what is termed "the methodical open-up of mineral reserves".

The Penoles Co., of Mexico, which was purchased by Mexican interests after the new Mining Law came into force earlier this year (see *The Mining Journal*, April 28, p. 467), has announced plans for the construction of a zinc refining plant in Torreon, with an initial annual capacity of 30,000 tonnes. A refinery may possibly also be built at Saltillo.

The Australian Government has authorized the export of a further 200,000 tons of iron ore from a deposit in North Queensland, known as Willets Knob. This ore will probably be shipped to Japan.

Premier Steel Mills in Canada is investigating the feasibility of pumping powdered iron through a pipeline from the Peace River area to ports on the West Coast, a distance of about 400 miles, where the powder would be processed into pig-iron for export. The powder would be obtained from ore at Hines Creek, where a deposit, estimated at 230,000,000 tons averaging 34 to 36 per cent iron is reported.

A geologist from Hunting Technical Services has been working with Mackay and Schnellman, of London, in a detailed examination of iron ore prospects in Goa, including air photographs and a drilling programme.

The Venezuelan Minister of Mines, has recently visited Sweden to study the possibilities of creating an organization of iron ore exporting countries, with the object of stabilizing selling prices.

Final agreement has been announced on the financial details of the three-year plan for the development of Bolivia's national mining industry (see *The Mining Journal*, Sept. 8, p. 227). Credits totalling \$37,760,000 are to be authorised by the U.S., Germany and Argentina. During the first year \$16,000,000 will be invested in exploration, rehabilitation and modernization. The announcement stated that payment to the former groups, Patino, Aramayo and Hochschild, would be suspended temporarily while the total sums to be paid in compensation were defined.

## PERSONAL

Nuclear Developments Ltd., a private company recently formed by I.C.I. Ltd. (Metals Division), Rolls-Royce Ltd. and The Rio Tinto Co. Ltd. has appointed the following board of directors. Chairman J. N. V. Duncan, Directors: R. W. Wright, Sir Mark Turner, J. D. Pearson, A. A. Rubbra, L. Barman, Dr. J. Taylor, St. J. de H. Elstob, Dr. R. L. P. Berry.

The National Coal Board announce that Mr. J. R. Caseley, director of production, opencast executive is to retire at the end of October. Mr. F. C. Baker, at present the executive's finance director is to become director-general, opencast executive as from November 1, 1961. Mr. L. H. Clemetson has been appointed to the executive as director (production) and Mr. C. H. Allen as director (finance), both appointments to date from November 1, 1961. Mr. Caseley is being retained as consultant to the opencast executive.

Dr. D. G. Christopherson, Pro-Vice-Chancellor of the University of Durham and Warden of the Durham Colleges, will give the first annual lecture of the British Conference on Automation and Computation (B.C.A.C.) in the lecture theatre of The Institute of Electrical Engineers, Savoy Place, London, September 27 at 5.30 p.m.

Mr. G. Essame at present the staff director of the West Midlands Divisional Board, has been appointed principal of the National Coal Board's Staff College at Chalfont St. Giles in succession to Mr. N. G. Fisher, whose resignation has been announced.

Mr. Howard Lanier, formerly quality control engineer at Utah Copper Division refinery of Kennecott Copper Corp. has been transferred to Kennecott Sales Corp. with headquarters in New York City, where he will be manager of selenium and columbite sales.

The board of directors of The Cementation Co. Ltd. has appointed Mr. Henry A. Longden a director, deputy chairman and chief executive of the company with effect from October 1, 1961.

Mr. John M. O'Brien has arrived in Britain to assume his appointment as sales manager for Caterpillar Tractor Co. Ltd. Mr. Earl W. Doubet, Mr. O'Brien's predecessor with British Caterpillar, has already left Britain to take up his new position as European Division sales manager for Caterpillar Overseas, S.A., Caterpillar's marketing subsidiary in Geneva.

Mr. E. J. Robinson has been appointed a director of The Head Wrightson Export Co. Ltd. and Mr. R. F. N. Otway has joined the company as manager—Europe.

Mr. Cecil F. Hurst has been appointed managing director of Samuel Osborn & Co. Ltd. Mr. Hurst is now deputy chairman and assistant managing director of the company.

Mr. L. J. Davies has been appointed a director of Research. He was previously director of research of AEI (Rugby), and he is succeeded in this position by Dr. J. E. Stanworth.

Eimco (Great Britain) announce the appointment of Mr. A. R. Hilton to the post of mining projects engineer.

Mr. E. T. Pinkney, at present consulting chemical engineer in the Anglo American Corp. of South Africa's head office at Johannesburg, has been appointed consulting metallurgist (development) in Salisbury with effect from January 1, 1962. He will work in conjunction with Mr. F. H. Chapman, the Corporation's consulting metallurgist in Rhodesia. Mr. C. P. A. Louwrens, now a consulting mechanical engineer in Johannesburg, has now been appointed to succeed Mr. A. H. W. Busby, the Corporation's consulting mechanical engineer in Rhodesia, who is retiring from this post on December 31, 1961. Mr. Busby will remain a further three months in the Salisbury office to complete his responsibilities in connection with the new I.S.F. plant at Rhodesia Broken Hill and development work at Rhodesia Congo Border Power Corp.

## From magnetite to monazite—

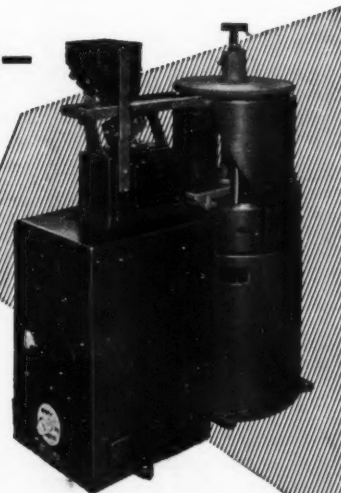
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## Metals and Minerals

## Cobalt's First Silver Refinery

Although the Cobalt district in Northern Ontario, Canada, has been mining silver for more than fifty years, it has not hitherto been a regular producer of silver bullion. A few years ago an attempt was made to establish a silver-cobalt refining operation, the emphasis being on the recovery of cobalt with silver as a by-product. This plant, which was operated by Quebec Metallurgical Industries, could not compete with the refinery at Deloro and was closed in 1955. It is now owned by Cobalt Refinery Ltd., and is once more in production but this time with silver as the main metal, though equipment is to be installed for the recovery of both cobalt and nickel oxides from the speiss that remains after the silver has been extracted. For several months the plant has been treating low-grade residues left by Quebec Metallurgical Industries, but silver concentrates from Langis Silver are now being handled and bullion of 99.9 per cent purity is being produced. The official opening ceremony took place early in August. It is noteworthy that the general manager, Mr. J. N. Cram, gained his experience in smelting and refining silver at the Deloro smelter, which recently closed down.

The capacity of the plant is stated to be slightly higher than the normal average production of silver concentrates in the Cobalt area. Ores, concentrates and metallics are being accepted for treatment from mines in the area. Apart from refined silver, the company hopes to produce some 300-350 tons of refined arsenic per year and will be Canada's sole producer (in quantity) of this commodity. No difficulty is anticipated in selling cobalt and nickel oxide.

According to *The Northern Miner*, the bullish market outlook for silver has touched off a new wave of exploration and development in Cobalt, where a number of companies are engaged in exploration and development programmes which could grow into extensive operations.

It has been officially stated by the Yugoslav Government that the steep rate of increase in silver production, which last year reached 94,083 kg., will continue in the coming years. The main purchasers are Federal Germany, France, the U.K. and the U.S. Yugoslavia's copper ores are reported to contain between 10 and 35 grms. silver per tonne and its lead and zinc ores between 100 and 150 grms.

## INDIAN MINERAL EXPORTS

Mica exports from India in the first half of this year declined to 13,360 tonnes from 17,230 tonnes in the corresponding period last year. Despite the decline in quantity, the earnings from the export of mica in January-June 1961 rose to Rs 51,600,000 from Rs 49,500,000, thanks to higher prices obtained for the commodity in the world markets.

Out of the total exports in January-June, 1961, block mica accounted for 1,230 tonnes, splittings for 3,600 tonnes, and other grades for 8,530 tonnes, the relative figures for the first half of 1960 being 1,280 tonnes, 3,770 tonnes and 12,180 tonnes respectively. Exports to the U.K. were 790 tonnes of splittings, 216 tonnes of blocks,

and 2,287 tonnes of other grades of mica. The U.K. was the largest buyer of Indian mica, Germany being the second largest (offtake 2,490 tonnes) and the U.S.A. the third largest (offtake 2,140 tonnes).

Exports of kyanite from India in the first six months of 1961 increased to 15,340 tonnes valued at Rs 3,940,000 from 8,840 tonnes valued at Rs 2,300,000 in the first half of last year. The U.K. topped the list of buyers of Indian kyanite during the period, with an offtake of 4,530 tonnes (value Rs 1,180,000) followed by the Netherlands and the United States with 3,260 tonnes and 2,320 tonnes, respectively. Other important buyers were France with an offtake of 1,880 tonnes and Italy with 1,520 tonnes. Kyanite was also exported to five other countries, namely, Japan 760 tonnes, Belgium 710 tonnes, Czechoslovakia 250 tonnes, Canada 90 tonnes and Australia 2 tonnes.

## COLUMBIUM IN SPACE

Columbium, because of its high conductivity at low temperatures when its resistance to electricity diminishes, has been selected for manufacture into a small ball spherically accurate to one millionth of an inch for use as a key part in guidance systems for jet planes, space vehicles and possibly submarines.

The ball, only  $\frac{3}{4}$  oz., must be accurately round as possible because it is suspended in a vacuum and rotates in gyroscopic fashion to determine true north more accurately and much faster than systems hitherto used, according to General Electric scientists.

The metals from which the ball is manufactured cost about \$80 an oz. and, after high precision machining and polishing, the ball costs around \$4,000.

## LONDON METAL AND ORE PRICES, SEPT. 14, 1961

## METAL PRICES

Aluminium, 99.5%, £186 per ton  
Antimony—  
English (99%) delivered, 10 cwt. and over £230 per ton  
Arsenic, £400 per ton  
Bismuth (min. 1 ton lots) 16s. lb. nom.  
Cadmium 11s. 0d. lb.  
Cerium (99%) net, £15 0s. lb. delivered U.K.  
Chromium, Cr. 99% 6s. 11d./7s. 4d. lb.  
Cobalt, 12s. lb.  
Germanium, 99.99% Ge. kilo lots 2s. 5d. per gram  
Gold, 250s. 51d.  
Iridium, £20/£23 oz. nom.  
Lanthanum (98%/99%) 15s. per gram

Magnesium, 2s. 2½d./2s. 3d. lb.  
Manganese Metal (96%/98%) £275/£285  
Nickel, 99.5% (home trade) £660 per ton  
Osmium, £17/£22 oz. nom.  
Osmiridium, nom.  
Palladium, Imported, £8 12s. 6d.  
Platinum U.K. and Empire Refined £30 5s.  
Imported £27 7s. 6d./£27 17s. 6d.  
Quicksilver, £62 ex-warehouse  
Rhodium, £43/£45 oz.  
Ruthenium, £14/£16 oz. nom.  
Selenium, 46s. 6d. per lb.  
Silver, 79½d. f. oz. spot and 80½d. f.d.  
Tellurium, 37s. 6d. lb.

## ORES AND OXIDES

Antimony Ore (60%) basis .. .. . 30s. 0d./33s. 0d. per unit c.i.f.  
Beryl (min. 10 per cent BeO) .. .. . 270s./275s. per l. ton unit BeO  
Bismuth .. .. . 65% 8s. 6d. lb. c.i.f.  
18/20% 1s. 3d. lb. c.i.f.  
Chrome Ore—  
Rhodesian Metallurgical (semifriable 48%) (Ratio 3:1) .. .. . £15 5s. 0d. per ton c.i.f.  
" Hard Lumpy 45% .. .. . (Ratio 3:1) .. .. . £15 10s. 0d. per ton c.i.f.  
" Refractory 40% .. .. . £11 0s. 0d. per ton c.i.f.  
" Smalls 44% .. .. . (Ratio 3:1) .. .. . £13 5s. 0d. per ton c.i.f.  
Pakistan 48% .. .. . (Ratio 3:1) .. .. . £11 15s. 0d. per ton f.o.b.  
Columbite, Nigerian quality, basis 70% combined pentoxides (Ratio 10:1) .. .. . 150s./160s. 0d. per l. ton c.i.f.  
Nb<sub>2</sub>O<sub>5</sub>:Ta<sub>2</sub>O<sub>5</sub> .. .. .  
Lithium Ore—  
Petalite min. 31% Li<sub>2</sub>O .. .. . 50s. 0d./55s. 0d. per unit f.o.b. Beira  
Lepidolite min. 31% Li<sub>2</sub>O .. .. . 76s. 0d./80s. 0d. per unit f.o.b. Beira  
Amblygonite basis 7% Li<sub>2</sub>O .. .. . 75s. 0d./85s. 0d. per ton f.o.b. Beira  
Magnesite, ground calcined .. .. . £28 0s./£30 0s. d/d  
Magnesite Raw (ground) .. .. . £21 0s./£23 0s. d/d  
Manganese Ore Indian—  
Europe (46% 48%) basis 60s. 0d. freight .. .. . 73d./75d. c.i.f. nom.  
Manganese Ore (43% 45%) .. .. . 69d./71d. c.i.f. nom.  
Manganese Ore (38% 40%) .. .. . nom.  
Molybdenite (85%) basis .. .. . 10s. 0d. per lb. (f.o.b.)  
Titanium Ore—  
Rutile Australian 95/97% TiO<sub>2</sub> (prompt delivery) .. .. . £25/£25 10s. per ton c.i.f.  
Ilmenite Malayan 50/52% TiO<sub>2</sub> .. .. . £11 10s. per ton c.i.f.  
Ilmenite Travancore 58/60% TiO<sub>2</sub> .. .. . £15/£15 10s. per ton c.i.f.  
Wolfram and Scheelite (65%) .. .. . 124s. 6d./127s. 6d. per unit c.i.f.  
Vanadium—  
Fused oxide 95% V<sub>2</sub>O<sub>5</sub> .. .. . 7s. 6d./8s. per lb. V<sub>2</sub>O<sub>5</sub> c.i.f.  
Zircon Sand (Australian) 65-66% ZrO<sub>2</sub> .. .. . £16 ton c.i.f.

## KITIMAT RESTARTS PRODUCTION

The Kitimat smelter of Aluminium Co. of Canada has resumed production operations after a three-month close down. Only 500 of the 1,900 workers in the company towns were employed during the summer. The smelter was closed on June 19 after rockfalls had occurred in the 10-mile tunnel providing the hydro electric power for generators at Kemano. It has cost around \$2,000,000 to repair the tunnel.

## FURTHER EXPANSION OF QUEBEC LITHIUM

Quebec Lithium Corporation, which only last month revealed its plans to enlarge its refinery facilities to produce a second lithium salt: lithium hydroxide mono hydrate (*The Mining Journal*, August 18, p. 171), has decided to expand its plant still further, according to *The Northern Miner*, to produce lithium metal and lithium chloride. It appears that the company expect to complete their plant design plans so as to be able to go ahead with construction and the installation of plant by next spring.

All the major units of equipment for the hydroxide plant have been ordered and some of the machinery has already started to arrive on the site. The company hope to start production by next December. The cost of the hydroxide plant has been put in the region of \$300,000. It has been designed for a capacity output of 2,500,000 lb. a year.

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#### CANADIAN POTASH MINE EXPANSION

International Minerals and Chemical Corporation (Canada) has announced its plans to more than double the capacity of its potash mine project at Esterhazy, Saskatchewan. A company spokesman said that agricultural demand for North American potash has been rising at an average rate of 6.5 per cent.

Output capacity of the Esterhazy mine is to be raised from 420,000 to 1,200,000 tons a year at an estimated cost of \$10,000,000 which will bring the company's total investment to nearly \$40,000,000. The first production from Esterhazy is expected next summer with the higher rate scheduled for early 1963.

#### U.S. PRIMARY ANTIMONY

Output, consumption, imports and stocks of primary antimony all declined during the second quarter compared with the previous quarter, according to the U.S. Bureau of Mines.

Smelter production of primary antimony declined two per cent in the second quarter, production of oxide rose 25 per cent but output of the metal fell by 11 per cent. However, the total smelter output of 5,600 tons for the first half of this year was 15 per cent above the 4,900 tons produced during the corresponding period of last year. The increase has been attributed to larger outputs of metal and by-product antimonial lead.

Consumption of 2,700 tons of antimony during the second quarter was 14 per cent below that of the preceding quarter and about 600 tons below the quarterly average for 1960. While there was little change in the use of oxide consumption of the metal fell by 300 tons in the second quarter compared with the figure for the first quarter of this year.

Metal products took 56 per cent of the primary antimony consumed and non-metallic products the balance.

Imports of antimony fell by 15 per cent below the import level of the first quarter and were 8 per cent below the quarterly average for last year. Receipts of ore and concentrates, mostly from Mexico and the Union of South Africa increased but metal receipts were more than 600 tons below the level of the first quarter. Yugoslavia supplied almost half of the imported metal and the U.K. supplied about one-third and nearly all the oxide imported by the U.S. during the second quarter.

\*

Consumption of antimony metal and compounds in the U.K. rose in June to 460 tons from 432 tons in May, according to the British Bureau of Non-ferrous Metal Statistics. The gain largely reflected the increased use for batteries which absorbed 165 tons in June against 127 tons in May while small increases occurred in sulphides (including crude) at five tons against three tons and oxides for white pigments 130 tons against 129 tons.

Declines were recorded in antimonial lead uses other than for batteries which took 42 tons in June against 50 tons in May, oxides for uses other than white pigments 80 tons against 83 tons and miscellaneous uses 16 tons against 18 tons. Use in bearings was unchanged at 22 tons.

#### MANGANESE ORE

Although the holiday season is now virtually over, there are no signs as yet of any revival in the demand for manganese, according to trade quarters.

European steel production is being maintained at a very good level, while in Japan it has increased. But this has had no material impact on the ore market. Users' ore requirements generally are being met through long-term contracts, and in consequence the level of demand to contractual obligations is meagre. Moreover, with supplies of ore from all sources reported to be plentiful, there is no particular urgency for buyers to extend their commitments.

In the United States there is still plenty of room for improvement in the steel industry. An improved rate of activity there, however, is not expected significantly to quicken the rate of buying. Not only have consumers good stocks, but there are ample supplies at competitive prices from South America.

In the circumstances, prospects appear as bleak as ever for any upturn in prices, even of a very limited extent. For 46/48 per cent ore the price remains quotably unchanged at from 66d. to 68d. per long ton unit c.i.f. Europe. The United Kingdom should be in a good bargaining position when negotiating supplies for next year as her stocks are, if anything, increasing.

### Copper • Tin • Lead • Zinc

(From Our London Metal Exchange Correspondent)

With the exception of the price of zinc quotations are relatively unaltered from last week, although the basic situations in the copper and tin markets have undergone a radical change which should influence prices in the next few weeks.

#### COPPER'S LATENT STRENGTH

The behaviour of the copper market has underlined the latent strength of the metal as, in spite of the settlements of strikes in Chile and the United States and a slight easing of the scrap metal price in America quotations, after an initial weakness, have regained the level existing a week ago. In the U.S. the Kennecott strike has been settled and there are reports that metal for sale during the rest of this month and during October is not too plentiful. In view of this Phelps Dodge have announced that the cut-back in production is being suspended, which means an increased supply of about 3,000 tons of metal a month. In Europe there has been a certain amount of demand for metal to replace that lost by the Chilean strike but at the time of writing the pressure is not sufficient to raise quotations. In Chile a period of 60 days has been set for reaching agreement of a new contract at El Salvador and it is hoped that agreement will be reached within that time. At the same time it must be remembered that the contract at Chuquicamata expires at the end of this year and that demands for a new contract must be settled by October 1.

In view of the serious affect which a strike in the copper industry has in Chile it is to be expected that some overall agreement will be reached with regard to strikes with copper workers, as the present strike has resulted in the loss of 40,000 tons upward of metal with a corresponding loss of revenue to the Chilean Exchequer. Stocks in official warehouses increased by 170 tons to a total of 21,884 tons and the contango rate remains unchanged.

#### PLATINUM TRADING

In contrast to the desultory trading conditions which have persisted in the free platinum here for some time past, the two leading refiners in the United Kingdom report that business is quite healthy. One of them, in fact, said they are now busier than they have been for some months.

Two important outlets, the glass and steel industries, are taking useful amounts of the metal; the requirements of the former are understood to be growing. As a catalyst, the metal is also in good demand from the oil and pharmaceutical industries. The refiners' price to their regular customers continues to be quoted at £30 5s. per troy ounce. It has stood at that level since January of last year, and demand appears sufficient to keep it there.

Continental demand is also keeping up well, notably in West Germany and France, while in the United States one of the refiners remarked there had been a revival of demand in the United States.

#### NEW SPANISH ALUMINIUM PLANT

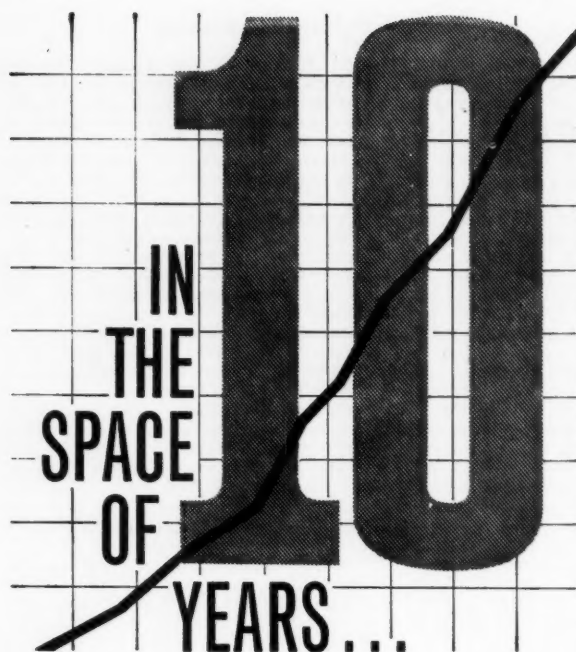
A new aluminium plant, *Aluminio de Galicia S.A.*, has been officially opened near La Coruna. It is understood that production is expected to increase in stages up to 60,000 tons a year some of which may possibly be for export.

#### WHAT PRICE TIN?

The tin market has had a number of interesting happenings to assess. The first of these, reported last week, was the application by the G.S.A. to Congress for the release of 50,000 tons of tin over an unspecified period and this was followed over the weekend by the news that application was being made for the waiving of the 6 months' notice normally necessary for the first 10,000 tons of this release. As was to be expected these items of news caused a wave of selling which forced the price down to the mid £940's per ton, but on Wednesday it became known that the G.S.A. had refused to accept any of the tenders put in for the thousand tons of Longhorn Tin offered on Tuesday, although it is understood the highest bid was only a little short of 120c per lb. At the same time it was announced that the adjourned meeting of the I.T.C. would commence on October 9 and there is much gossip as to what negotiations and exchange of information has taken place between the G.S.A. and the representatives of the International Tin Council.

As the news of the application for release has drawn sharp protests from producing countries, especially Malaya and Bolivia, Tuesday's action of the G.S.A. is being interpreted as an indication that sales of stockpile tin will not be made at under the going market price provided this price is below a certain level, and the big unanswered question is "what is the level which the G.S.A. feel is high enough". The majority opinion is that the price of forward tin is liable to fluctuate between £995 and £975 for the next few weeks. The contango has shown signs of contracting and stocks in official warehouses fell by 102 tons to a total of 5,526 tons at the beginning of the week.

A correction with regard to shipments of tin from Penang during August has been given, the figure now standing at 6,475 tons against the 6,620 tons reported last week.



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On Thursday the Eastern price was equivalent to £963½ per ton c.i.f. Europe.

#### MINED OUTPUT OF LEAD-ZINC DECLINES

Turnover in the lead and zinc markets has increased during the last week and whereas the price of the former has remained relatively stable the price of the latter has gone down by another £2 0s. 0d. per ton and it is generally expected that a further decline will take place between now and the end of the month. In the U.K. stocks of lead showed a further increase of 725 tons to a total of 10,883 tons, whilst zinc stocks rose by 474 tons to a total of 7,074 tons but in spite of this the contango has remained relatively stable. The latest figures from America for zinc show a slightly improved position as smelter's stocks at the end of August were the lowest since November of last year at 188,090 s. tons; deliveries were up for the month by almost 13,000 tons at 84,271 s. tons, which is the highest figure since March 1960; U.S. production during the month was also the smallest since November at 65,757 tons as compared with 69,755 tons in July.

It is reported that the mined production of both lead and zinc declined during July, the former by about 9 per cent to 20,800 s. tons and the latter by 9 per cent at 36,500 s. tons. The production of lead, however, for the first 7 months of the year was still about 4 per cent in excess of the corresponding period of 1960.

#### U.K. STATISTICS

The British Bureau of Non-Ferrous Metal Statistics have issued the following figures for the consumption of the four non-ferrous metals in the United Kingdom for the month of July with the corresponding June figures in brackets:—

	Tons	
Consumption of copper	54,556	(63,694)
End of month stocks	142,969	(145,267)
Consumption of tin	1,747	(1,822)
End of month stocks	8,697	(9,151)
Consumption of lead	28,369	(32,966)
End of month stocks	63,367	(62,286)
Consumption of zinc	27,814	(30,536)
End of month stocks	65,328	(67,798)

#### OFFICIAL TURNOVERS

Official turnovers (in 1. tons) for the week ending September 8, with the previous week's figures in parentheses are:—

Copper .. ..	14,150	(16,325)
Tin .. ..	2,815	(2,210)
Lead .. ..	7,100	(8,375)
Zinc .. ..	7,525	(8,125)

Closing prices are as follows:

	September 7		September 14	
	Buyers	Sellers	Buyers	Sellers
COPPER				
Cash .. ..	£232½	£232½	£231½	£232
Three months ..	£235½	£236	£235	£235½
Settlement ..	£232½		£232	
LEAD				
Current ½ month	£64½	£64½	£64½	£64½
Three months ..	£65½	£66	£66	£66½
TIN				
Cash .. ..	£953	£954	£945	£946
Three months ..	£963	£964	£955	£956
Settlement ..	£954		£946	
ZINC				
Current ½ month	£74½	£74½	£72½	£72½
Three months ..	£75½	£75½	£73½	£73½

### Mining Finance

## The Meaning of the G.S.A. Announcement

The announcement by the General Services Administration that it had requested Congress to authorize the disposal of 50,000 tons of pig tin set off a reaction in the commodity market which was quickly reflected in the share market; at the close of last week leading tin shares fell by as much as 8 per cent. This reaction, it must be assumed, was based on the belief that at least six months notice had to be given before any disposals could be made from the strategic stock piles, and thus, when it was announced that the G.S.A. had asked Congress to waive the six months period for the disposal of 10,000 of the 50,000 tons the reaction was even more marked. Leading shares fell by a further 5 per cent making some 13 per cent in all. In the metal market the price of tin fell from £981 per ton to £940 per ton on the first announcement and then a further £5 when it was learned that an application had been made for the six months period to be waived.

This behaviour must be accepted as typical of such a highly speculative market but it is not necessarily a true reflection of the meaning of the United States announcement to the tin industry as a whole. Many of the world's trading centres have condemned the United States action for various reasons. Some regarded the first announcement as ill-timed and have suggested that the request to waive the six months waiting period is definitely undermining the stability of the tin market.

These must surely be the reactions of the short-sighted and of the speculators who cannot claim to have the interests of the industry at heart, for, in the long term, the guarantee against a chronic shortage of the metal which the United States announcement gives is a very strong bull point for the industry.

Many have argued that the present high price of tin is not the result of a genuine metal shortage but the result of speculative buying; in part this may indeed be so but it must be recognized that the speculators are only anticipating the physical shortage that would be certain to develop early next year if there were no releases from the American strategic stockpile. Once the impending shortage had become a fact then a runaway market would be bound to develop and prices could go sky high. This in itself would do the industry untold damage, but more important is the fact that once it was established that a metal shortage was bound to exist for a period, regardless of price considerations, the search for substitutes would increase ten-fold and whilst there appear to be no easy substitution materials for tin in its major markets, experience has shown that in times of need substitutes can be found for anything. (It should not pass unnoticed that in Johannesburg beer is now being marketed in plastic containers instead of tin cans.)

Many of the more shortsighted reactions to the G.S.A. application must be based on the assumption that the price of the metal will fall with any stockpile sales. Is this a valid deduction? On the present information most certainly not; in fact the most that can be said with any certainty is that, provided Congress approval is obtained, the possibility of a runaway market has been averted. If the price of

tin is to fall then it must be assumed that it is the intention of the United States to sell their stockpile at say £950 per ton or less; no one can know the intentions of the United States for they are formulated by Congress, but it is unlikely that Congress could agree to the stockpile being sold at less than its purchase price which is generally accepted to be over £1000. Furthermore, any plans to sell tin at less than £1000 could hardly be reconciled with the Government's foreign policy towards Bolivia.

The General Services Administration has stressed the fact that the tin would be released in small quantities with due regard for the protection of producers, processors and consumers and this has been confirmed by the recent rejection of all bids for the 1,000 tons of Longhorn brand tin. The highest bid was \$1,953 per lb., equivalent to £956 per ton, and it was rejected on the grounds that it represented an inadequate return to the United States Government. However, with speculators operating on the market it is probable that the price which Congress sets as the selling price for the stockpile will become the general selling price. It is not possible to do more than guess what this price will be, but considering the various influences that will be brought to bear upon Congress, the limits can possibly be set between £1050 and £1200 per ton. The lower limit would be governed by the desire to provide an "adequate return" on the stockpile and also by foreign policy considerations, whilst the upper limit would be imposed by the home consumer interests.

Can the promise of an adequate supply of metal and a price between these limits be taken as other than a bull point for the industry? As Sir Ewen Fergusson commented in Kuala Lumpur the action by the G.S.A. "appeared to be in the interests of producers and consumers alike".

With this general background to the commodity market one is perhaps forced to the conclusion that the fall in the share market was also unwarranted; compared with its previous level this is so, but as has been suggested in these columns before (*The Mining Journal* July 7, 1961), the Eastern share market has been rather overvalued and after the recent fall it is now a more realistic reflection of the various companies' prospects. Share market movements are always bound to be rather more violent than actual metal price movements, for an improvement of one per cent in the metal price can give a very much greater percentage increase to the dividend. However, in the violence of these movements, the pendulum is often apt to swing too far. This is essentially what had happened at the end of June. The buffer stock manager's pool had been exhausted, the metal price had risen way above the I.T.C. ceiling to £920 per ton, and in the share market prices rose to levels which have yet to be surpassed. At these high levels the share market was discounting metal prices associated with a runaway market. Since that time the share market has eased gradually and with the latest fall the leaders have lost about 20 per cent overall, thus bringing them back to reasonable yield levels, discounting over the next eighteen months a substantial increase in the average price of tin but not a runaway market.

Whilst it can be understood that people

interested in mines with short lives might be disappointed with this latest move the industry as a whole must surely be grateful for the period of respite that, if approved, the disposal of 50,000 tons of tin will give. Within the reasonably near future it should be known at what price the United States intends to sell its tin and in turn this will be a prime indicator to both the mining and consuming industries as to the likely level of tin prices for several years to come. The mining industry should be able to move forward more confidently with plans for developing, albeit at considerable capital expenditure, the low grade deposits that are known to exist whilst the consumer interests can investigate the possibility of substitutes for that section of its products where the new higher price levels definitely warrant their use.

In this way the tin position could again reach a reasonable balance and during this respite the International Tin Council will have an important part to play in assisting both mining and consumer interests to establish this balance. The I.T.C. have announced that the postponed August meeting is now to be held in London on October 9. The purpose of this meeting is probably to discuss the cost figures which the members have been asked to prepare and to consider what recommendations they might make to the United States. There is, of course, no official link between the U.S. government and the I.T.C. but it is to be hoped that America would not go ahead with stockpile sales without consulting the Council.

#### KINTA KELLAS-WORKING FOR THE FUTURE

In his annual statement the chairman, Mr. T. H. Macer, has outlined the company's plans for making improvements to its dredge towards the end of the current financial year. It is proposed to fit a new bucket band and to improve the recovery plant on the dredge and to mechanize the shore plant. These improvements will not only mean a better recovery of fine tin from the current production but will also enable the company to re-work the large dump of tin shed discards. It has been estimated that the direct cost of these works will be £34,000.

The overall cost of these works, however, is bound to be far more than this direct estimate, for the cost of the loss of production early in 1962 must be considered. At that time the price of tin will almost certainly be higher than it is today and the loss of one or two months' production will be very expensive. American economists have insisted for a number of years that capital works and expansion programmes must be initiated and completed if possible during periods of depression and with Kinta Kellas the tin restriction period appeared to provide the ideal opportunity. Had a bold decision been taken earlier and these modifications made during the period of restriction, then the overall costs to the company would have been considerably less. However, these arguments are not a case for still further delay and whilst the profits during the current year will be lower than might otherwise have been obtained, the company should again earn substantial profits and should be able in the future to reap even greater rewards from its existing reserves.

One must assume that the life of the property is at least medium, if not long, but the only direct guidance that shareholders have received on this point was given in 1958 when the chairman referred

to the "very considerable ore reserves". It is to be hoped that at the meeting to be held in London on September 28, the chairman will be more specific.

The company has been repaid its contributions to the first buffer stock pool, which were given in the balance sheet at £22,798 and a distribution, representing profit, should be made in the near future.

#### UNION CORPORATION DIVIDENDS

The final dividends of both St. Helena and Winkelhaak mines have been increased from the previous year's level. At St. Helena the final has been increased to 50c. bringing the total payment for the year to 53c. (5s. 3.6d.) compared with 50c. (5s. 0d.) for the previous year. Little more than this modest increase could have been expected now that the company's tax-free holiday is over. During the first six months of the current year taxation has taken about 50 per cent of the profits and this figure will increase further when lease formula payments become due in full. Nevertheless, the outlook is for expanding profit margins and the dividend should continue to climb steadily, albeit slower than in the past.

At Winkelhaak a comparison with the previous year is hardly valid as this is the first year that both an interim and a final dividend have been paid. The interim was 5c. and the final has now been declared at 6c. bringing the total to 11c. (1s. 1.2d.). Taxation on this new mine is still a long way off, the assessed loss at June 1961 being about R 9,854,000. Prospects at Winkelhaak are still very good and the recent borehole announcement was particularly encouraging.

Drilling in the northern section over the last eighteen months has considerably enhanced the long term prospects of the property, the latest borehole WS 39 show-

ing the best values to date. The original intersection gave 65.06 dwts. over a width of 25.9 inches, equivalent to 1,685 inch-dwts. and the deflection assayed 56.32 dwts. over 26.6 inches equivalent to 1,498 inch-dwts.

#### KENTAN GOLD AREAS AND THE CONGO

Since the merger between Kentan Gold Areas and Zambesia Exploring late in 1958, Kentan's main interests have been either in the Congo or, at least, associated with it, namely the Union Minière du Haut Katanga, and the Benguela Railway, the latter being a Portuguese registered company operating the line between Lobito and Elisabethville and the Rhodesian Copperbelt. Both these investments are held through Tanganyika Concessions whose financial year ends on July 31 compared with March 31 for Kentan and December 31 for both Union Minière and the Benguela Railway. There is, therefore, a substantial timelag element in the Kentan accounts which means that the company's immediate future is dependent upon events often two years old.

This accounts for the fact that Kentan's income from investments has increased from the previous year, for the accounts reflect Union Minière's increased dividend payment of Belgian Francs 2,200 per Part Sociale in respect of 1959. Despite the troubles in the Congo 1960 was a record year for Union Minière in terms of production; however, the directors have decided to reduce the dividend to Belgian Francs 1,500 per Part Sociale and this will be reflected in Kentan's accounts for 1962.

In both 1959 and 1960 the Benguela Railway's dividend has been maintained at 12½ per cent though the results for 1960, which will also be reflected in Kentan's 1962 accounts, have shown a

### London Market Highlights

After having steadied following the previous week's tumble, tin share prices took a new turn for the worse on Monday of last week. The move followed news of the G.S.A. request for a waiver of the normal six months waiting period on a release of 10,000 tons of the 50,000 tons of tin sought from the U.S. national stockpile. Selling was by no means heavy but it made a sharp impression in this sensitive sharemarket. Tronoh dropped 4s. 6d. to 65s. 6d., Ayer Hitam 4s. to 47s. 6d. and Gopeng 3s. 6d. to 42s.

Selling dried up on Tuesday and a few cheap buyers appeared, although they were very selective. Wednesday saw the recovery go a stage further when in line with the rallying metal price, shares notched up a good list of gains. Tronoh came in for a particularly good enquiry which was stimulated by the one-for-one scrip issue news and the shares recouped 3s. to 68s. 6d. Prices are still well below the levels ruling before the original G.S.A. shock, but the earnings position of the producers still looks unlikely to be unduly affected by any U.S. moves.

South African gold shares continued their rather dreary pattern of daily losses of a few pence in extremely idle trading conditions during Monday and Tuesday. Johannesburg, on the other hand, stayed firm with the result that the margin between prices in the two centres widened to between 20 and 25 per cent. London

sentiment began to take note of this on Wednesday and although business here stayed modest, share prices brightened by a few pence throughout the list. Free State Geduld improved 1s. 3d. to 81s. 3d. on hopes that the imminent final dividend would be maintained. Lorraine jumped 1s. to 17s. 6d. as some bear closing developed here in response to Johannesburg talk of good development values. St. Helena, however, remained unmoved at 57s. 6d., despite the previous dividend announcement which had fulfilled the expectations.

Rhodesian Coppers which had earlier been holding up well in rather uninspiring market conditions began to fall back on Tuesday. Wednesday's news of the flare-up in Katanga accentuated the movement. Thus on the three days, Rhokana came back 2s. 9d. to 43s., Rhodesian Anglo American lost 1s. 9d. to 53s. 3d. and Nchanga were 1s. 6d. down at 45s. Chartered, which had previously been unmoved by the maintained interim, eased 1s. 6d. to 58s. 6d.

Oddly enough, the Katanga issues were little affected. In Brussels, Union Minière rallied from an initial setback to close only 10 francs down on the day at 1,300 francs; the London price was in fact slightly up on balance at £9 10s., the movement being a reflection of the previous day's firmness in the Belgian price. Tanganyika Concessions, an important holder of Union Minière, eased only 3d. to 18s. 9d.

substantial improvement, the net revenue having increased from £1,967,727 to £3,057,324. This increase in revenue reflects the increase in traffic from Katanga to Lobito as a result of the diversions from the route to Matadi through the Congo. The railway has not been affected by the disturbances in Northern Angola.

The Geita Gold Mine, Kentan's subsidiary, has made a small profit on the year's operations. The working profit for the year amounted to £14,157 but after charging an exceptional item, a provision for obsolete stores, together with other small items, the net profit for the year was £1,209 reducing the loss carried forward to £84,213.

Two years ago, in these columns, the Kentan shares were described as very reasonable, standing at an 8½ per cent yield. Today, as a result of the political events throughout Central and Southern Africa, the yield is 18½ per cent. Every investor must make his own decision with regard to politics, but as far as Kentan's holding's are concerned both Union Minière and Benguela have improved technically since 1959.

**The Diamond Corporation.**—It has been announced that a new subsidiary, the Diamond Corporation Cote d'Ivoire Limited (registered in London), has been granted a licence to buy diamonds on the open market in the Ivory Coast. Buying operations at Abidjan started on August 29.

**Geevor Tin Mines.**—Extracts from the chairman's statement appear on page 276. The report and accounts of Geevor Tin Mines were discussed in these columns in the issue of August 25.

## Personal

Mr. Keith C. Acutt, who joined the board of the Consolidated Mines Selection Co., last May, has been appointed chairman of the company in succession to the late Mr. A. C. Wilson.

## Company News

Aveling-Barford Ltd. announce the purchase of Hoveringham Engineering Co. Ltd. from Hoveringham Gravels Ltd., for the approximate price of £300,000. They will continue to operate under their own name within the Aveling-Barford Group.

Joy-Sullivan announce that a new division, to handle the design, construction and installation of electrical and mechanical precipitators has been formed. This move is the result of the merging, in 1959, of Western Precipitation Corp. of Los Angeles with Joy Manufacturing Co. of Pittsburg, parent company of Joy-Sullivan Ltd. General manager of the new division is Mr. Kenneth H. Cree.

F. Taylor & Sons (Manchester), a wholly-owned subsidiary of Steel & Co., and Richard Sutcliffe, announce that they have jointly secured exclusive manufacturing and marketing rights in Great Britain, and most Commonwealth countries, for the SECOMA mobile drill carriages, bolting platforms and other mobile mining equipment. Until the British-built machines are available, the markets served by these two companies will be supplied from the French factory.

## Rand and Orange Free State Returns for August

### GOLD OUTPUT AND PROFIT

Company	August 1961			Year ends	Current Financial Year Total to date			Last Financial Year Total to date		
	Tons (000)	Yield (oz.)	Profit† (R000)		Tons (000)	Yield (oz.)	Profit† (R000)	Tons (000)	Yield (oz.)	Profit† (R000)
<b>Gold Fields</b>										
Doornfontein	124	53,630	621.8	J	249	107,130	1252.6	210	85,922	884.5
Libanon	119	30,290	169.8	J	238	60,545	346.4	234	55,870	269.7
Rietfontein	12	3,149	3.1	D	96	25,748	23.8	126	33,083	96.9
Robinson	52	9,951	3.9	D	354	77,885	22.4	356	78,845	LI.2
Simmer & Jack	72	12,344	2.2	D	561	100,723	5.5	608	107,913	L90.5
Sub Nigel	66	15,142	26.2	J	133	30,164	52.9	133	30,361	60.5
Venterspost	128	39,040	204.4	J	255	77,267	406.7	248	69,114	305.6
Vlakfontein	53	19,640	186.7	D	420	154,781	1488.5	413	148,201	1399.0
Vogels	80	17,312	25.0	D	645	138,311	219.6	685	147,546	325.9
West Drie	182	142,783	2444.9	J	362	283,185	4880.5	260	242,342	4304.2
<b>Anglo American</b>										
Brakpan	146	18,888	67.2	D	1,147	145,392	388.2	1,144	138,361	199.7
Daggas	224	45,361	445.2	D	1,806	365,330	3628.3	1,855	374,796	3642.8
East Daggas	108	18,523	86.0	D	860	147,012	677.0	843	143,030	652.5
F.S. Geduld	99	87,026	1410.8	S	1,064	926,721	15074.7	1,036	890,311	14274.1
President Brand	132	102,391	1736.5	S	1,352	1,063,755	18356.8	1,279	1,041,920	18285.5
President Steyn	111	41,933	331.8	S	1,189	445,460	3710.9	1,117	431,352	3861.7
S.A. Lands	110	22,185	100.2	D	864	174,551	811.2	776	161,239	714.4
Springs	96	14,131	50.3	D	750	105,994	306.2	817	113,632	228.7
Vaal Reefs	116	54,230	568.1	D	856	400,645	4316.9	787	354,152	3689.9
Welkom	105	33,531	137.2	S	1,096	348,188	1480.0	1,083	341,837	1652.5
Western Holdings	179	122,063	2090.5	S	1,826	1,254,833	21440.1	1,621	1,073,535	17715.2
West Reefs Ex.	155	45,182	312.5	D	1,203	230,045	2389.4	1,123	316,937	2114.2
<b>Central Mining</b>										
Blyvoor	145	89,906	1351.7	J	283	176,230	2667.7	271	176,225	2657.9
City Deep	117	23,760	15.0	D	919	188,918	45.8	910	186,712	86.9
Cons. M.R.	39	8,739	3.0	J	78	17,713	6.1	121	23,663	18.6
Crown	184	32,342	3.5	D	1,448	252,376	21.3	1,605	271,588	100.5
D. Roodepoort	202	37,869	105.4	D	1,547	287,413	804.8	1,544	282,539	790.6
East Rand Prop.	254	58,137	199.5	D	1,902	430,373	1184.3	1,780	436,966	1339.7
Harmony	202	81,403	789.3	J	404	162,705	1585.4	340	136,093	1253.5
Modder East	63	6,470	1.0	S	124	12,830	1.1	263	25,806	3.4
Rose Deep	27	4,245	0.5	D	184	32,575	13.2	194	34,445	20.4
<b>J.C.I.*</b>										
Freddies Cons.	65	13,443	L29.9	D	509	105,520	L356.2	481	106,881	L638.6
Govt. G.M.A.	35	7,965	L21.4	D	317	65,024	L134.1	423	86,596	8.1
Randfontein	16	3,457	1.2	D	137	24,487	11.3	196	38,709	47.6
<b>Union Corporation</b>										
East Geduld	129	36,249	438.6	D	1,011	286,929	3469.1	1,061	310,839	3986.4
Geduld Prop.	81	13,000	37.1	D	631	101,383	332.5	592	104,129	178.6
Grootvlei	227	46,935	472.0	D	1,742	360,520	3544.9	1,732	360,372	3675.6
Marievale	102	24,225	243.8	D	788	189,674	1929.8	791	193,435	2016.3
St. Helena	190	66,507	861.3	D	1,469	515,089	6623.2	1,298	439,619	5445.6
Van Dyk	77	11,214	5.0	D	592	92,514	97.3	588	97,282	145.8
Winkelhaak	99	33,660	362.7	D	762	259,309	2797.6	688	217,228	2066.1
<b>General Mining</b>										
Buffelsfontein	155	68,022	760.0	J	307	134,461	1520.1	293	120,252	1296.0
Ellaton	23	5,498	26.5	D	194	45,484	242.1	228	53,975	399.5
S. Roodepoort	81	7,515	46.5	J	61	14,765	91.1	61	14,604	93.1
Stillfontein	185	83,065	875.7	D	1,419	641,021	6885.6	1,286	580,166	6112.9
W. Rand Cons.	141	20,364	33.8	D	1,077	159,083	272.3	1,060	152,083	126.2
<b>Anglo Transvaal</b>										
Hartebeestfontein	136	62,560	697.9	J	272	125,120	1403.9	240	111,598	1271.1
Lorraine	85	27,625	120.9	S	914	242,255	208.2	865	181,153	L420.6
Rand Leases	192	26,112	L15.2	J	384	52,224	L34.4	388	56,158	48.3
Village M.R.	36	4,344	L3.5	J	73	8,668	L6.5	62	9,056	L9.9
Virginia O.F.S.	140	26,896	L89.9	J	283	55,353	L204.1	192	40,345	L295.4
<b>Others</b>										
N. Kleinfontein	72	10,126	2.5	D	585	80,904	41.6	623	81,209	7.7
Wit. Nigel	19	4,277	6.1	J	39	8,550	13.6	40	8,868	20.8

Gold has been valued at R25.03 (July R25.17) per oz. fine. L indicates loss. † Working Profit. Table excludes profits from Uranium, Pyrite and Acid, and also production from Uranium divisions at Randfontein and W. Rand Consolidated. \* Working profit includes Sundry revenue.

### ESTIMATED URANIUM REVENUE

Company	Year ends	Aug. Profit (R000)	This year (cum.) (R000)	Last year (cum.) (R000)	Company	Year ends	Aug. Profit (R000)	This year (cum.) (R000)	Last year (cum.) (R000)
<b>Gold Fields</b>					<b>J.C.I.*</b>				
Doornfontein	J	32.0	64.0	60.0	E. Champ d'Or (a)	D	9.1	76.1	109.5
Luipaards Vlei (a)	J	265.0	530.0	374.6	Freddies Cons. (b)	D	65.0	519.0	492.0
Vogels	D	105.0	876.0	868.0	Govt. G.M.A.†	D	30.0	312.0	368.7
West Drie	J	102.0	204.0	196.0	Randfontein (b) (c)	D	279.8	2224.8	1694.1
<b>Anglo American</b>					<b>General Mining</b>				
Daggafontein (b)	D	254.0	2047.0	2253.7	Buffelsfontein (d)	J	259.4	514.6	852.0
P. Brand (b)	S	94.0	988.8	1008.8	Ellaton (d)	D	3.5	30.2	274.0
P. Steyn (b)	S	129.0	1361.2	1351.9	Stillfontein (d)	D	10.8	251.5	1428.0
Vaal Reefs (b)	D	152.0	1181.8	2375.4	W.R. Cons. (c) (d)	D	222.6	2451.8	3333.1
Welkom (b)	S	121.0	1293.1	1286.9	<b>Anglo Transvaal</b>				
West Reefs Ex. (b)	D	104.0	797.2	2592.5	Hartebeestfontein (d)	J	428.0	851.0	1000.0
<b>Central Mining</b>					Lorraine (d)	S	65.0	744.0	760.0
Blyvoor (b)	J	160.0	325.0	652.0	Virginia O.F.S. (d)	J	265.5	547.2	664.0
Harmony (b)	J	395.1	785.1	1025.2					

Table includes profit from uranium, acid and pyrite, before loan redemption. (a) Including profit from gold section. (b) Including royalty provision. (c) Total profit from uranium section. (d) Excluding royalty provision. \* Net revenue. † Uranium royalty received. ‡ Pyrite.

## PUBLICATIONS RECEIVED

**Mines and Miners of Cornwall—1. Around St. Ives**, by A. K. Hamilton Jenkin. Published by the Truro Bookshop, Truro. pp. 50, price 7s. 6d.

Throughout his life Mr. Hamilton Jenkin has been keenly interested in the Cornish mining industry and his earlier works have established him as a leading historian in this field. For the past fourteen years he has concentrated primarily on research into the lesser known mining ventures of Cornwall, the existence and progress of which can be traced only by an immense amount of original and painstaking research. It is intended to publish the results of this research in a series of regional parts, each with map and illustrations, which will ultimately cover the whole of the county. These parts will be similar in style and layout, so that the complete work, estimated to extend to some 950 pages, can be shelved as a uniform series or can be bound into a combined volume.

It was of the older, little known or entirely forgotten mines that Mr. Hamilton Jenkin originally intended to write, to the exclusion of all those previously described in the standard literature. In the course of his research, however, he found that the material he was examining, much of it contained in the files of *The Mining Journal*, related to mines which were already known but antedated anything that had previously been written of them. It was therefore decided to make use of it. Even so, the mines described in the new series have been chosen on a selective basis. Having established the existence of many hitherto forgotten mines, every effort has been made to locate them in the field, and patient search has often proved rewarding. In the first volume alone, which makes fascinating reading, some 40 mines are described. This work, when completed, will be a notable contribution to the published records of Cornish mining history.

An illustrated booklet entitled *Diamond Mining in the Desert* has been published by the Consolidated Diamond Mines of South-West Africa, which tells the story of South West Africa's diamond industry, and the growth of Oranjemund, the company's mining headquarters and residential centre.

The Aluminium Development Association have published their latest *Directory of Members* which is now obtainable without charge from the Association. This Directory, in its revised form has been divided into two parts, the first being an index of products, and the second part giving full particulars of member companies.

The 1961 edition of *Buyers' Guide*, obtainable from British Pump Manufacturers' Association, 94-98, Petty France, London, S.W.1, is complementary to the Handbook of the British Pump Manufacturers' Association. It enables purchasers of pumps and pumping plant to obtain information on the various types manufactured by the members of the Association.

*A Preliminary Account of Beryllium Occurrences in Canada* is given by Robert Mulligan in Paper 60-21, issued by the Geological Survey of Canada. Price 50 c. It consists of short notes on more than fifty localities where beryllium minerals have been found in single occurrences or compact groups.

The Curie point of a substance is defined as the temperature at which that substance abruptly loses its spontaneous magnetization upon being heated. This property depends only upon the chemical composition of a ferromagnetic substance and it may thus be used to identify the members of ferromagnetic solid solution series found in rocks. Bulletin 69 of the Geological Survey of Canada, *Design of a Curie Point Meter* by A. Larochelle, published by the Department of Mines and Technical Surveys, price 50 c., describes an instrument of the torsion-balance type, using a photoelectric recording mechanism. Details of the various components of the instrument and an outline of its calibration are also given.

The British Iron and Steel Federation has brought out an *Anglo-Russian Glossary of Commercial Expressions*. This glossary covers many terms not found in the ordinary dictionary, and has included complete phrases instead of single words, wherever possible.

Canada's mining industry continues to expand and seems heading towards another record year in 1961, in spite of difficulties. Many major projects, involving millions of dollars, have been completed in the past year, and many more are in progress or planned. Full details of these developments are recorded in the analyses of Canadian mining companies contained in the *Canadian Mines Handbook—1961*, published by Northern Miner Press; pp. 311, price \$4 (paperbound) and \$5 for de luxe binding. The new edition lists over 3,600 companies and contains more than 300 new company names. The special sections have been revised and brought up to date. "Range of Mining Share Prices" gives highs and lows from 1954 to May 31, 1961, for mining stocks listed on the Toronto, Canadian and Vancouver Stock Exchanges, and there is a 27-page coloured section of mining maps.

*The Colliery Year Book and Coal Trades Directory 1961* is the 39th edition of this important work of reference for the coal and allied industries, published by Iliffe Books Ltd. Price 45s. net (46s. 9d. by post), 916 pages. The book has been comprehensively revised and supplemented where necessary, to ensure that the 1961 edition is completely up-to-date. Particularly to be noted is the addition of all latest amendments to the Mines Regulations. The book's coverage is very comprehensive and the system of thorough sub-division and classification, makes information quickly accessible. The foreword to this 1961 edition has been contributed by the Rt. Hon. Alfred Robens, P.C., chairman of the N.C.B.

## GEEVOR TIN MINES

The forty-eighth Annual General Meeting of Geevor Tin Mines Limited was held on September 13 in London.

Mr. G. W. Simms (Chairman) presided, and the following is an extract from his statement for the year ended March 31, 1961:—

The working profit for the year was £65,613.

At the last Annual General Meeting I stated that there was no intention of attempting to de-water the undersea workings of Levant Mine, but further investigation and consideration of the possibilities as regards development led to the conclusion that we should attempt to seal the breach in the sea bottom connecting to the old workings, provided a firm of Civil Engineers, experienced in such operations, thought well of the project. Messrs. John Mowlem & Co. were therefore consulted and Messrs. Reed & Mallik Ltd., a firm of diving experts, were employed to make a thorough examination of the breach. After considering their report, Messrs. John Mowlem & Co. expressed the opinion that provided weather conditions were favourable there is reason to hope it may be possible to seal the breach. This work was put in hand and is now in progress. If successful, it must react favourably on the future of this Company.

Your Company is also interested with other friendly mining interests, in investigating the possibilities of the old Cligga Mine by means of exploratory Diamond Drilling. Although only a few holes have been drilled to comparatively shallow depths, results justify further exploration.

The report was adopted.

Sir John Cass College is holding two courses of evening lectures on Electronic Computing Systems. Part I will be given from October 25 to November 29 and Part II from January 17 to February 21, 1962. The course is intended for executives and others interested in the commercial applications of electronic computers.

A Symposium to celebrate the Fiftieth Anniversary of Froth Flotation in the U.S.A. will be held in Denver, Colorado, from September 17 to 20, 1961, under the auspices of the A.I.M.E.

The Proprietor of British Patent No. 797106 for "A METHOD OF ANCHORING BOLTS OR THE LIKE IN BORES OR CHANNELS, PARTICULARLY IN CHANNELS OPENING OUT DOWNWARDLY, e.g. DEAD-END BORES DRILLED IN THE ROCKY TOP WALL OF UNDERGROUND ROOMS, AS WELL AS A MEANS FOR CARRYING OUT SAID METHOD", desires to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder. Further particulars may be obtained from Marks & Clerk, 57-58, Lincoln's Inn Fields, London, W.C.2.

